

MEMOIRS

OF

THE GEOLOGICAL SURVEY OF INDIA.

MEMOIRS
OF
THE GEOLOGICAL SURVEY OF INDIA.
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Hughes.

G E O L O G I C A L S U R V E Y O F I N D I A

Memor. Vol. XXI Pt. 3.



J. Schauburg, Lith.

HESTHO RIVER

Printed at Geod Survey Office
Hughes Phot.

KIRWAHI WATERFALL - COAL SEAM AT BASE.

MEMOIRS
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THE GEOLOGICAL SURVEY OF INDIA.

THE SOUTHERN COAL-FIELDS OF THE REWAH GÓNDWÁNA BASIN: UMARIA,
KÓRÁR, JÓHILLA, SOHÁGPÚR, KÚRÁSIA, KORÉÁGARH, JHILMILI, by
THEODORE W. H. HUGHES, A.R.S.M., F.G.S., *Geological Survey
of India.*

CHAPTER I.

GENERAL REMARKS.

SECTION I.—INTRODUCTION.

IN different numbers of the Records of our Survey, I have already
partially sketched the geology of portions of the
country that it has now fallen to my task to de-
scribe in full; but as they were merely preliminary
notices I would wish it to be understood that the views expressed in
them were based upon contemporaneously progressive knowledge, and
were therefore open to modifications as maturer and fuller observations
were accumulated. My chief aim has been to
give prominence to the coal deposits which were
met with, and I think I may point with some satisfaction to the result
of the joint labours of my colleague Lála Hira Lál and myself in connec-
tion with the investigations of the coal-measures in the neighbourhood of

Umaria. The fortunate discovery on his part of
fossils which definitely confirmed my conviction as
to the true geological horizon of the coal encouraged the hope that, if

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sanction could be obtained for practically testing the area by borings, the previous conceptions as to the poverty and worthlessness of the coal might possibly have to be modified.

So long as the Umaria coal was supposed to be of upper-Góndwána age, and that was the opinion entertained of it up to the time of our examination,¹ it would have been running counter to our experience to have recommended a special scheme of exploration ; but so soon as the coal was shown to be of Damúda age, there was sufficient presumptive evidence to warrant an appeal for assistance to determine its positive value.

An agreeable surprise awaited me in the responsive readiness with which Captain Barr, the Political Agent of Baghél-response to suggestions. khand and Superintendent of Rewah, met my suggestions, and having arranged that I should superintend and direct operations, he furnished all the necessary sinews of war.

The expenditure up to the present amounts to something over R34,000, of which R25,000 have been absorbed by salaries and labour in nearly equal portions.²

Of those associated with me during the exploration, Mr. T. G. Stewart has the credit of having put down the first series of borings, by which preliminary know-

¹ The statement in the text is not complete ; the history is as follows : This ground was first examined geologically by the late Mr. J. G. Medlicott, at a time when we knew very little indeed regarding the groups of the Góndwána rock-system. On the map then published (1859), Umaria (Umaria) is on the lower Damúda, i.e., the true coal-measure rocks (Memoirs, II, part 2, p. 171) ; but so also were placed the undoubtedly top Góndwána beds (Jabalpúr) on the Málhánadi. In 1868-69 I made a traverse of all these rocks between Házáribágh and Jabalpúr, and then detected the Tálchirs along the gneissic promontory north of Umaria. In 1871-72 Mr. Hacket undertook the detailed survey of that ground with the new large-scale maps. His work was so manifestly incomplete and faulty, all the rocks from the Málhánadi to Páli on the Jóhilla being coloured as Jabalpúr, that it was condemned as useless. Thus, the age of the Umaria coal was very much an open question when Mr. Hughes took up the work which he has completed in so thorough a manner. It is very good of Mr. Hughes to distribute to others the professional credit that is virtually all his own ; to find fossils when one is told to look for them, is a very small contribution towards the final result.—H. B. M.

² Extract : Financial report, Rewah Coal Explorations, from 1st January 1882 to 30th June 1884—

| | | | |
|--------------------|---------|--------|-----|
| Salaries | R13,829 | 13 | 9 |
| Labour | „ | 12,670 | 1 6 |

ledge of the Umaria and Jóhilla fields was gained. The more import-

Mr. T. Forster, M.E., and Mining Assistants. ant duties of Mining Engineer were discharged by

Mr. Thomas Forster, M.E., whose name came into prominence in connection with the extinction of the disastrous fire of 1882 in the Warora Colliery. The Assistant Mining Engineers, MM. Hallett and Munsch, during their connection with the coal explorations, performed their duty efficiently and willingly. The latter had special charge of the borings in the Kórár coal-field, and recorded his observations with minute precision. I am sorry to say that while residing at Jabalpúr, after the close of the season, he died from weakness of heart, and we have thus lost an intelligent and conscientious worker.

I have to acknowledge my obligation to Captain Barr for his unweary-

Captain Barr, acknowledg- ing promptitude in sweeping away difficulties as they ledgment of assistance. arose, some having their origin in the irritation of the native chiefs who deemed their rights invaded, and of petty officials whose dignity was compromised by the presence of foreigners, and others having their source in the unforeseen contingencies of a novel undertaking. In securing and moulding labour we should have been perfectly helpless without Captain Barr's aid, and the end of our researches would have been in the far future, instead of having its termination in the season 1883-84. It is no detraction from the service rendered to us, that we were working in the interest of the Rewah State; the professional reputations of all were at stake, and they would have been seriously impaired if apathy on the part of the Political Agent had prolonged the term of our probation.

I would enter a warning concerning village sites. In many instances the present hamlets are at some distance from the positions indicated on

Village sites, shifting. the maps. This is due to the migratory and shifting habits of the Gónd and Baigá tribes, who, from one cause or another, rarely remain stationary for more than six or seven years. Over and over again have I been the victim of misplaced confidence in the accuracy of my Atlas-sheets, and it was not until experience had enlightened me, that I found out on whose shoulders the blame of my

troubles should properly be placed. The maps are now fifteen to twenty years old, and considerable changes have taken place since they were completed.

The task of writing this memoir has been committed to my care, but the observations embodied in it are the result of the joint labours of my colleague Lála Hira Lál and myself. At the outset of the survey, he was entrusted with the examination of the Metamorphic, Tálchir, Laméta, and Trappean boundaries, but during the last two seasons he was apportioned a share of the more arduous and more important task of prospecting for coal and tracing the limits of the Barákar group in the Koréa and Jhilmili States. Without the aid that he ungrudgingly gave, it would have been most difficult in face of the many interruptions that I received to my more legitimate work, to have completed in so short a time the survey of the large area which engaged our attention.

SECTION II.—PHYSICAL DESCRIPTION.

The area described in this memoir forms a portion of the great central basin of Góndwána rocks occupying a large part of the country drained by the Són and some of its southern leading tributaries and principally comprised within the limits of the Rewah State.

In touching upon the various physical and geological features, I have been guided in selecting a starting-point by the circumstance that

Description proceeds from west to east. The western end of the basin is nearer to the station of the East Indian Railway, whence our annual departure for our season's work took place. It would have been as easy, so far as describing them was concerned, to have commenced in the east, but this would have been an inversion of the order in which the survey was actually carried through.

The range of our observations extended proximately for a distance of 150 miles from Long. $80^{\circ} 45'$ E. to Long. $82^{\circ} 55'$ E., and I have

Area surveyed. been able to add the link required to connect the investigations of MM. Hacket and Mallet in the

Jabalpúr district, with those of MM. Ball and Griesbach in the Gurját States of Chútia Nágpúr.

The limits to the west and east are the two tributaries of the Són, the MÁhánadi¹ and the Rér; the boundary to the north is the boundary of the supra-Barákar rocks, and the extension southwards is demarcated by a varying fringe of stratigraphical deposits. As thus defined, the different rock formations occupy an area of nearly 3,200 square miles, of which about 870 are included in the zemindaries of Koréa and Jhilmili.

The leading title that has already been applied to denote this area,

Name of area. namely, the Rewah Góndwána basin is the most comprehensive and convenient one that has been proposed, and I would certainly retain it in preference to amplifying for the mere purpose of including the territory which is beyond the fiscal limits of the Rewah State. Mr. Ball gave the separate name of Jhilmili coal-field to the coal bearing rocks of the Jhilmili estate, and Lála Hira Lál proposed the designation of Koréagarh for a small outlier in Koréa; but as these are integrant portions of the Góndwána basin, they have been subordinated to the weightier claim of Rewah, as a representative title, and in this way share the lot of the Umaria, Kórár, Sohágpur and other coal centres.

Physical aspect. The physical aspect of the country is very varied, but its most prominent characteristic is its hilliness.

The chief highlands are, those to the north, marked by the famous hill fortress of Bndgarh and the numerous detached peaks and lesser ranges belonging to the same system, extending far to the east and west beyond our area; the uplands of Kora, the watersheds of the Jhilla, Sn, and Hestho rivers, and the great plateau of the Deccan (Dkhan) trap to the south. There is a gradual rise from west to east, and from north to south. At Umaria in $80^{\circ} 54' E.$ Long. and $23^{\circ} 23' N.$ Lat., which I mention in likelihood of its becoming a

Level above sea, place of repute, the height of the plain above sea level is 1,490 feet; and thence there is a slow

¹ This is not to be confounded with the greater Mâhânâdi of Cuttack (Katak).

and regular increase of elevation to 2,477 feet in the neighbourhood of Súnhat, the capital of the Koréa State on $82^{\circ} 25'$ E. Long. The loftier peaks, such as Bándógarh, Koréágarh, Mahóra, and the crests of the Dakhan uplands, of which Amarkantak is one, are respectively 2,662 feet, 2,955 feet, 3,371 feet, and 3,400 feet high.

The hills vary in shape according to the rocks of which they are made up. Those of Bándógarh and its associates

Hills.

are usually flat topped with precipitous sides for

some distance down, and then a sloping termination of broken rocks and stones to the foot, preserving a steady alignment for long distances or sweeping in full curves. This is the characteristic form produced by the sculpturing of the Máhádéva and other supra-Barákar sandstones, and is quite distinct from the scarped facing of the trappean plateau, which is much more irregularly eaten into, and has not the same prominent accumulation of debris at its base.

The small independent hills, of trap, sandstone, or shale, have no definite contour, and are narrow or broad, conical or lumpy, as the caprice of Nature has determined.

The highlands to which reference has just been made constitute the watershed of several of the larger rivers of India.

Rivers.

Of these, the Són more immediately concerns us; as, though the Narbada rises in the Amarkantak plateau, a part of Rewah, it soon passes into the territory of the Central Provinces, and beyond the scope of our notice.

The Són has its source in the Pendra table-land at an elevation of 2,100 feet, but it enters the Rewah State about 30

River Són.

miles from its origin, and a short distance above its junction with the Kéwai. Thence it flows in a generally northern direction, until it receives the Máhánadi. At this point, in $24^{\circ} 5'$ N. Lat., and $81^{\circ} 5'$ E. Long., it is diverted to the east, and holds that way until it falls into the Ganges.

Its feeders in its upper course are quite equal to it in size, and in fact the Kéwai, which has its origin in the uplands of Koréa, is a more important stream, and contains a greater volume of water.

Enumerating the tributaries that fall directly into the Són, they are Tributaries of Són. the Kéwai, Tipan, Kúnak, Múrna Jóhilla, Mágá-nadi, and the Rér. These two latter rivers, however, join the Són outside our ground, and consequently they appear on the map as independent streams. The Són is the essential river of the Rewah State, and it drains the whole of the Góndwána basin with the exception of the part in the Koréa zemindari.

There, the Hestho and the Géj constitute an independent drainage system, as they are affluents of the greater Mágá-nadi which empties itself into the Bay of Bengal. Rivers of Koréa. The watershed of the two systems is coincident with the territorial boundary between the Rewah State and Koréa, but that the uplands of the latter State should be apportioned to a drainage basin other than that of the Són seems an invasion of the latter's rights. A glance at the map certainly produces the impression that the Hestho has been needlessly intruded into the confines of the Són basin, as both to the east and to the west of it the neighbouring streams are tributary to the Són. The waters of the Hestho and its tributaries wend their way southward, in direct contrast to those of the Són and its feeders, which flow northward.

In many places the scenery is exquisitely charming, the hilly nature of the country that the streams run through lending itself especially to the indefinite multiplication of varied prospects. In the Jóhilla, that takes its rise near the sacred source of the Narbada, and flows to the lower level of the Góndwána basin, there are reaches as romantic as its own mythological story,¹ where it coyly steals in view, struggling slowly as it wends its way through overshadowing jámun and fringing tamarisks, and then gathering strength in some narrow gorge, it dashes, flecked with foam and to the music of its onward song, a candidate for our admiration. There are several falls in its course, but their

¹ The Jóhilla, the hand-maiden of Narbada, is said to have appropriated her mistress's jewels, at the time when arrangements were being entered into for the marriage of Narbada and Són, and presenting herself, decked with her borrowed charms, to the latter's view, so won upon him that he preferred the maid to the mistress. In wounded pride, Narbada turned her back upon them, and sought a home in the far west.

height is not great enough to make them imposing, and during the cold weather, which was my only opportunity for seeing them, the water passing over the dark basaltic sheets of the river channel was too attenuated to be a pronounced embellishment to the sombre background of the picture.

In the Hestho, and most of the streams directly and indirectly connected with it, there are some very striking waterfalls.

Waterfalls, and in the statistical account of the Tributary States of Chútia Nágpur, edited by Dr. W. W. Hunter, Vol. XVII, mention is made of one of the finest in the Hestho near the village of Kirwáhi falls—see wáhi.¹ A large volume of water is precipitated, and frontispiece. the sound of its falling can be heard for a long distance on a still evening. A representation of it from one of my own photographs forms the frontispiece of this memoir.

In the Kéwai there are long reaches of much-eroded sandstone, and the appearance of some of them struck me as being of sufficient interest to form another illustration of fluvial scenery.

There is a rank luxuriance of grass in all the lowlands and highlands, and wherever trap occurs. The latter is Grass. Spear grass. always a nursery for the worst form of spear grass, and for the several years that we have been engaged in tracing the boundaries of intrusions or overflows of volcanic origin, we have been compelled, where accuracy was a matter of necessity, to delay our examinations until the season was well advanced, and spring fires and migratory herds of cattle had assisted to clear the ground of this unwelcome hinderance to geological research. In all instances where I have been forced into contact with this baneful pest, I have deemed it a duty to inveigh against it, but no emphasizing can convey a proper sense of the condemnation that it deserves in the south Rewah and Koréa district. In the cold weather it possesses the charm of greenness; but the feeling of pleasure that this gives rise to is dashed by the disappointing knowledge that every stalk is armed with a sheaf of barbed arrows,

¹ Kirwáhi, 82° 24' E. long., and 23° 21' N. lat.

ready to pierce through breeches and socks, and rankle in one's flesh. There is probably no sportsman who has not anathematised this grass, and though an Indian geologist is wellknown as long-suffering and of many virtues, I question whether there is one who could plead "not guilty" of having consigned it to the region of Pluto.

Everywhere there is an abundance of coppice and jungle, but there are very few blocks of fair-sized timber. During the

Coppice.

construction of the Great Indian Peninsular Railway, the contractors for sleepers who rented the forests from the late Máhárája of Rewah, Raguráj Sing, cut and hacked mercilessly ; and now some years will have to elapse before the trees that are growing acquire useful dimensions. Of late, attempts have been made to induce the native fief-holders to conserve woodlands, but they look upon the suggestions laid before them as subtle traps to eventually deprive them of their forest rights.

In view of the construction of the railway from Katni to Umaria, and Scarcity of large timber. its future extension to Biláspúr, it would have been very convenient had there been a supply of ready-grown trees fit for sleepers ; and though the requirements of mining are less exacting, the existence of timber land near at hand would be of great consideration in estimating the advantages of a given coal-field.

The most universal forest tree is the *Shorea robusta* or *Saré*, and it Habit of *Shorea robusta* grows in all situations, but, as is wellknown, it is and *Boswellia*. not a lover of trap rock, and avoids those soils in which the special constituents of trappian matter preponderate. Its place in this instance is taken by *Boswellia* or *Sálé*, and so frequently is this a significant circumstance, that I have often been led to the discovery of some dyke or run of trap by noticing the presence of this tree. Probably there are many affections of this sort, but this is the only useful one that I know of to the geologist.

Bamboos, which are invaluable for numberless purposes, occur in and near to the plateau to the south ; also in the neighbourhood of Bándógarh, and along the banks of the Jóhilla and the Són. Then sparsely in the eastern portion of the

Sohágpur district; more plentifully in the border land of Rewah and Koréa, and in overflowing quantity in the latter State and that of Jhilmili. There are no bamboos in proximity to Umaria.

The abundance of coppice and grass land doubtless modifies the Climate pleasant. temperature, and renders the climate much more bearable in the warm season than if there were large open spaces of bare or cultivated ground. And certainly the widespread verdure of the jungle in May gladdens the sight, and makes one thankful to the destiny that has still preserved parts of this country from the encroachment of the ploughshare and the axe.

The landholders are principally Bráhmans and Baghél Rájputs, but Inhabitants. the tillers and hewers are the Gónds and Baigás, who were undoubtedly the original inhabitants of the country. These two tribes may be looked upon as the source from which colliers must be obtained when the opening of the Rewah coal-field on a large scale is decided upon. From my experience of them during the past five years, I think the Baigá is to be preferred to the Gónđ, being more hardy by nature and more deft with his hands. In the mines, the Baigás were certainly more fearless, as well as more staunch to their work. Their intelligence is of a low order, and they are slavishly susceptible to the promptings of their village elders. They have not courage enough to exercise their individual independence, and for some time to come they will require delicate handling before they are made to understand that coal mining is an occupation by which their interests will be advanced.

SECTION III.—PREVIOUS OBSERVERS AND GEOLOGICAL TABLE.

Of writers and others, as well as officers of our department, who Previous observers. come under the heading of previous observers, there is very little to remark. The published literature is meagre, and the manuscript reports refer only to a limited portion of the Rewah Góndwána basin, and do not pretend to be more than introductory traverses. The most useful notes for reference have

been compiled by the late Mr. J. G. Medlicott, and the geological lines that he laid down correspond closely to my own. As my opportunities for careful examination have been greatly in excess of those of any predecessor, I think it unnecessary to quote from them in order to contrast the advances that have been made in our knowledge during the last few years.

The following scale of succession indicates the geological divisions in and adjoining the Rewah basin that are noticed or Geological table. described in the present memoir:—

Surface deposits.
 Deccan-trap, with Lamétas.
 Góndwána system.
 Supra-Barákars, not yet worked out.
 Barákars, with Karharbáris.
 Tálchirs.
 Bijáwars.
 Metamorphics.

My researches have principally been confined to the coal-measures, and it is to them that the present memoir is almost entirely devoted, as the succeeding rocks still require further investigation before their position in the geological scale can be categorically affirmed. Under compulsion, I could, of course, assign a place to them, but I should have an uncomfortable consciousness that my decisions were open to correction.

The evidence afforded by the plant-remains which are gradually being collected, seems to point out a closer relation between the contiguous groups than was formerly allowed, and less stress must be laid on what were deemed lithological characteristics.

Evidence of closer relationship between the groups. This, however, is an alternative admission, depending upon the relative value that we accord to lithological and palaeontological evidence, whether what were deemed mineral characteristics are to be subordinated to the supposed fixed horizon of certain fossil plants, or whether those plants are to have a wider range in time. In the Damúda and Wardha

valleys the presence of ferruginous matter was in some cases testimony enough to determine the affiliation of the rocks, but this again was perhaps due to the imperfect measure in which their palaeobotanical resources were explored, and evidence was passed by, that might have tempered its value as a decisive index.

CHAPTER II.

IDENTIFICATION AND DISTRIBUTION OF ROCKS.

SECTION IV.—METAMORPHIC AND BIJÁWAR.

The Metamorphic series appears occasionally along the southern margin of the basin, between Lóra and Umaria, Metamorphic. in the Jóhilla Valley, at Bágħalwári, where the proposed railway line crosses the Basár stream, in the south-eastern part of the Sohágpúr district, and in Koréa and Jhilmili.

The inlier west of Umaria, forming the western shore margin of the Umaria coal-field, is of considerable significance in any speculative discussion on the facility of reaching the coal measures, presuming their extension in the direction of the Máhánadi. The cropping up of the Metamorphic rocks at Lóra points to the probability that the floor of deposition of the Góndwáná formation is at a shallow depth from the present surface.

The Bijáwars, represented almost entirely by silicious limestones, are confined to the strip of land between the Má Bijáwar. hánadi and the Machrár stream. With some modifications, the geological lines are those of Mr. C. A. Hacket's map. The only addition to the former known exposures is a small inlier near Narwár.

SECTION V.—TÁLCHIR.

Although the Bijáwar rocks are more recent than the Metamorphic Tálchirs not seen in series, it so happens that the Tálchirs are no- contact with Bijáwars. where seen to be in contact with them. They

rest always on the Metamorphics. Their most westerly exposure is in the neighbourhood of Kathai, and they run in a north-easterly direction through Lóra to Achala and Majgáma and then turn southward towards Baréri. Here they are overlapped by higher rocks, but they reappear in the vicinity of Máróhi Chandwár and Paunia. Their fullest developement is in the district of Sohágpúr, and they extend thence far to the south and east, connecting the Rewah area with the Tálchirs of the Máhánadi basin.

The identification of this group is perfectly easy, as it exhibits with two local exceptions the same lithological features that characterise it elsewhere. It seems gainsaying my own statement to assert that at one time I questioned the occurrence of

Lóra.

Tálchirs at Lóra. The point had been passed on to me to decide, and at first I was inclined to think that the Tálchirs were absent. This was a misapprehension, but it was due entirely to the fact that there were no sections open enough to decide a question that was already surrounded by controversial assertion. Had I wandered away either to the north as far as Lagwári, or to the south as far as Kathai, I should have met with Tálchirs in unmistakeable garb. It so happened, however, that it was not until two years after my first visit that I undertook the thorough examination of that part of the country, and arrived at the true knowledge of its structure. At the commencement of each season's tour, the tendency was always to press forward, and thus the places near at hand were passed over.

The recognition of Tálchirs at a given spot usually gives encouragement to the hope that we are within discoverable distance of the true

Tálchirs usually favourable coal measures, for we know as a fact that the able indication of coal. Tálchirs underlie the coal-bearing rocks. The application of this knowledge made me question the supposed geological horizon of the Umaria coal; and it has strengthened the expectations of meeting with coal where there is no actual exposure of it.¹ In tracing the outlines of the Tálchirs a great deal of time was spent in the mere

¹ The application of this same knowledge in the Sátpura basin did not meet with success, though it may still be said that the borings there were not carried deep enough. See Records, Vol. XI, p. 8; and Vol. XII, p. 97.—H. B. M.

drudgery of tramping many hundreds of miles of small and large streams to guard against inaccuracy as much as possible. They have been carefully mapped on a scale of one inch to the mile, but the exigencies of publication have necessitated the issue of a copy on a reduced size.

The boundaries near Umaria are for the most part conjectural, as the Tálchirs are only exposed once in the Umrár Umaria, Máróhi. river, at their contact with the metamorphic rocks south of Maróhi, and again in the small feeders of that stream east of Koilári; and near the tank at Chandwár. The whole of the remaining ground to the limit of the Barákar group is obscured by alluvium.

Kórár. Between Kótalwár and Kórár, where there is a small coal-field, there is an inlier of the Tálchirs in the Barákars.

In the valley of the Jóhilla they are again met with forming a distinct area. They are seen both north and south Jóhilla valley. of the inlier of metamorphics that extends from Mangthár to Pónri. Those to the south are not well exposed, but on the north side they stretch from Pónri to Bara Cháda. The bottom bed is a fine-grained compact brownish-grey calcareous sandstone; then above comes the famous boulder-bed, the matrix consisting of greenish-grey silt; the contained fragments are red binary granite, conglomeratic quartzite, quartzite and green schist. The bed is quite 80 feet, if not more, in thickness. To this succeed claret-coloured greyish-green and yellowish silts; one or two thin boulder beds; compact slightly calcareous sandstones; soft fine-grained, slightly pinkish and yellowish-grey sandstones, with felspar decomposed, and weathering with rounded outlines; then alternating silts and sandstones to the end of the section. There might possibly be a little doubt about including as Tálchirs the sandstones in the long reach of the Jóhilla, at the eastern end of which is the village of Goraia, were they seen alone; but most characteristic greyish-green splintery shales occur above them in the reach of the river near Bara Cháda that do away with all question as to their position. The Tálchirs extend only a very short distance inland from the

right bank of the Jóhilla, but they can be traced for 4 or 5 miles in the opposite direction, until they are overlapped by Lamétás and Barákars.

Leaving the valley of the Jóhilla and proceeding eastward, no Tálchir rocks are exposed until the edge of the Sohágpúr district. The main body in the Sohágpúr district is reached near Túrri at the base of the trappean plateau. Here they are made up of the same varieties of beds as occur in the Damúda valley, and the green and yellowish silts are the predominant rocks. Excellent sections of them are visible in the Són, the Hesia, the Álan, the Tipan and other rivers; and in several places I procured fossil ferns.

There is a local modification of some of the sandstones, which I think might mislead an observer who approached them with the ordinary Tálchir panorama before his eyes.

Their appearance at all events was questionable enough to raise, in my colleague's mind when mapping them, a doubt as to their true affinities. They occur on the isolated hills east of Nindauan and are compact and vitreous-looking, like quartzites; added to which, the accident of their resting on metamorphic rocks, and being represented where first seen by a slight thickness, strengthened the idea that they were members of the metamorphic series. On examining them carefully, however, it became evident that they were sandstones with the texture distinctly granular, not in the slightest degree crystalline, but rendered close and hard by calcareous matter. Eventually, decisive evidence of their specific character was obtained in one of the streams near the village, where they were found overlying a boulder-bed.

Throughout an extensive tract in the southern part of Koréa and Jhilmili, the Tálchirs are displayed in great force, and many of the higher hills are partly constituted of them. The boulder beds are more heavily weighted than they are in the west, and as a whole the group is of more importance. The lithological characteristics, however, are unaltered, and it is therefore unnecessary to dwell upon them.

The contacts of the group are almost all original ones, but there are a few small faults, the most noticeable being Fault. Bámhani Chilpa. the one south of Bámhani Chilpa, where there are two inliers of Tálchirs.

The thickness of the Tálchirs, where most freely developed, appears Thickness between 400 and 500 feet, but there are 400 and 500 feet. no sections continuous enough to furnish more than a proximate estimate. In the Jóhilla the figures would be about 400 feet, supposing an average dip of 5° to 6° over one mile of exposure.

Plant remains were discovered at different spots, but usually in such Plant remains. an imperfect state of preservation that it was not worth while keeping them. A few good specimens, however, were obtained, which Dr. Feistmantel has noticed in Vol. IV Pt. I. Fossil Flora of the South Rewah Góndwána Basin. They are—

Gangamopteris cyclopterooides.
Gangamopteris cyclopterooides, var. attenuata.
Gangamopteris major.
Gangamopteris comp. spathulata.
Glossopteris, sp.
Nöggerathiopsis hislopi.
Samaropsis.
Vertebraria indica.
Equisetaceous stems.

SECTION VI.—BARÁKARS.

There is satisfactory proof of the occurrence of this group over a large portion of Rewah, Koréa, and Jhilmili in the strong resemblance that its sandstones and other rocks bear to the typical representatives in the Rániganj field. Included with it are the beds containing a flora which partly coincides with that of the Karharbári group. I saw no

Karharbári flora. reason, however, either on stratigraphical or lithological grounds, for separating them from the Barákars, and consequently I have not mapped a line of demarcation. This may be a misfortune, so far as it fails to be in harmony with the restricted application of the palaeontological facts, but as the wider bearing of the evidence demonstrates a closer knitting of all the groups than has hitherto

been admitted, I am not yet ready to allow, in the absence of other testimony, that a sub-division of the Barákars is a necessity.

The same remark applies to the upper part of the group, where one or two plants may be referred to upper-Damúda forms.

By far the most abundant rock is, massively bedded yellowish-grey felspathic silicious sandstone, that undergoes mutations due to different degrees of decomposition in

the felspar, to the presence of calcareous matter, and to the changing size and relative proportions of the felspar and quartz grains.

Shaly sandstones and shales bear an insignificant proportion to the whole, and carbonaceous shales and coal are rare, though essential constituents of the group. Pebbles are not so frequently present as in other

Pebbles rare. localities, and there is an entire absence of the strong conglomerate beds that are so constant an

accompaniment of the lower portion of the Barákar group in the Jharia,¹ Bókáro, and Káranpúra fields of Bengal.

There are several exposures of the Barákar group; and as they can Several exposures of conveniently be described under separate heads, I Barákars. propose doing so for facility of reference. Relatively to the main body, which occupies a superficies of 1,587 square miles, the other areas are outliers of small extent, but the accident of geographical position has made the two westerly ones the most important economically, so far as immediate commercial considerations are concerned.

One of these is the Umaria coal-field, of which I have already written several notices, and on which the interest attaching to the coal resources of the Rewah Góndwána basin has for the last few years hinged. As it takes precedence in order of situation, according to the plan of description already adopted, I will refer to it in detail first.

Square areas. As a matter of interest, I give in column the exposed areas of the various fields:

| | |
|--|------------------|
| 1. Sohágpúr field or main area | 1,587 sq. miles. |
| 2. Kúráśia field | 48 , , |
| 3. Jbilumili field | 41 , , |

¹ Written Jherria in the Memoirs of the Survey.

| | | | | | | | | |
|----|----------------------------------|---|---|---|---|---|---|---------------|
| 4. | Jóhilla fields (north and south) | . | . | . | . | . | . | 14 sq. miles. |
| 5. | Korár field | . | . | . | . | . | . | 9 " |
| 6. | Koréágarh field | : | : | . | . | . | . | 6 " |
| 7. | Umaria field | . | . | . | . | . | . | 6 " |

SECTION VII.—THE UMARIA COAL-FIELD.

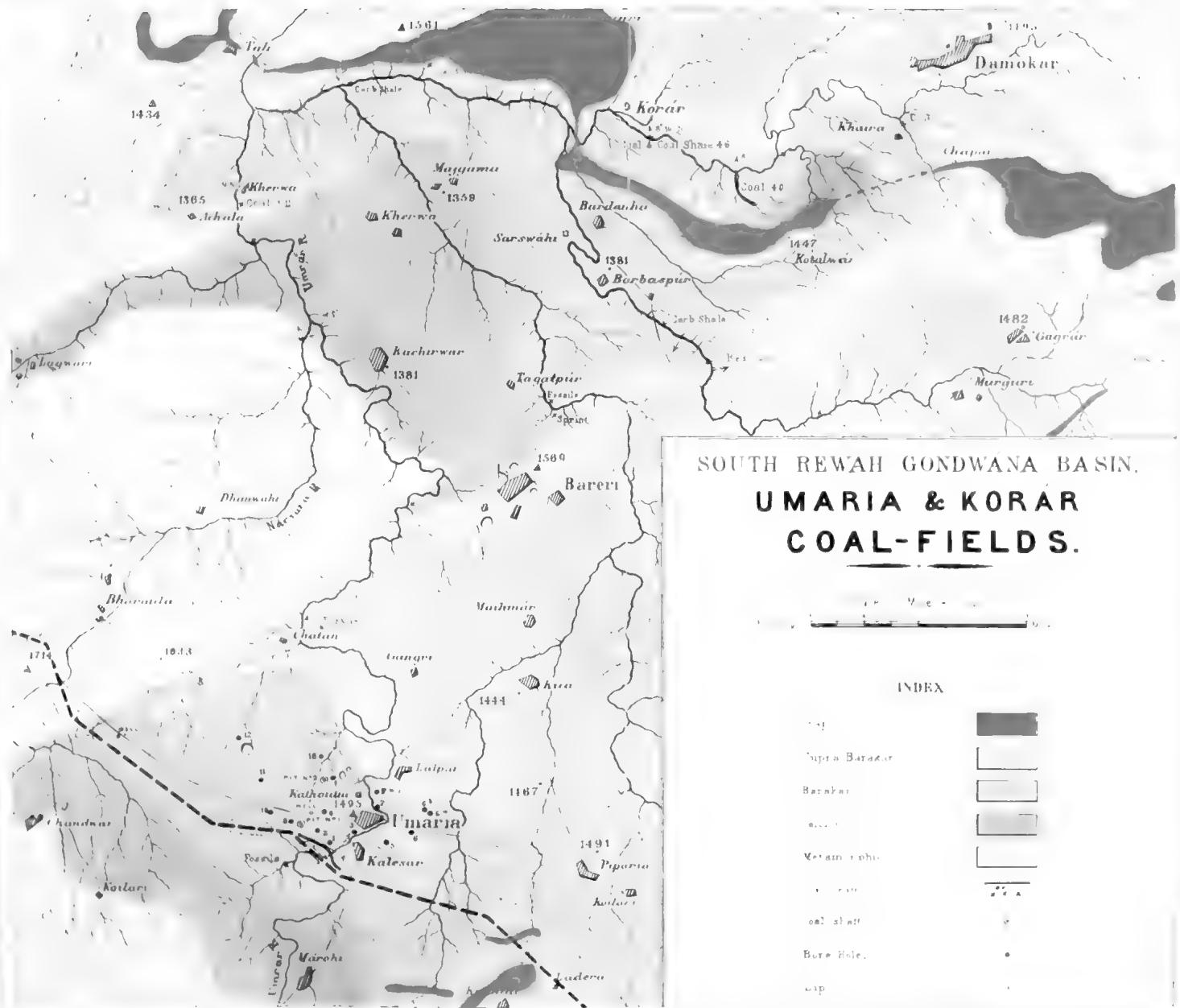
This name has been adopted from the village of Umaria, which occupies a nearly central position in the field, and is Umaria. a place of considerable importance. It is on the high road from Múrwára to Sohágpúr, and contains nearly 600 inhabitants, a permanent bazaar, police station, post office, and a forest outpost. A weekly market is held, and since the establishment of exploratory coal operations, traders of all descriptions have been attracted to the spot.

It is situated on the left bank of the Umrár river, a tributary of the Máhánadi, and is distant 36 miles from the station of Katni, on the East Indian Railway.

The most noted local points of reference are the fort of Bândogarh, 16 miles in a north-easterly direction, and the towns of Kauria and Chandia, situated respectively in latitude N. $23^{\circ} 36'$ and longitude E. $80^{\circ} 44'$, and celebrated formerly for the manufacture of native arms.

The field occupies moderately level ground, but along its western border is a low range of metamorphic rocks, and to the south and north are other hills composed of different formations. They assist in giving to the neighbourhood of Umaria a very picturesque aspect, and as there is no lack of trees and coppice, the scenery is in striking contrast with the cheerless coal-fields of Bengal.

The Umrár is the principal river of the district: it rises in the trap-
pean plateau to the south, and enters the area of the
River Umrár. Barákar rocks a little above Kálésar. Where it flows past the village, it is confined between rocky banks, sufficiently high to be noticeable. A somewhat imposing-dwelling-house belonging to the local Baghél chief, Chathar Dhári Sing, has been built on the cliff overlooking the stream; and certainly credit is due to whoever took



advantage of the situation ; for, during the cold weather, when the bed of the river is still moderately full, and ferns and other plants and climbing fig trees deck and festoon the banks, it presents a charming *coup d'œil* to the traveller who stays on his way to cool himself at the river ford.

With the exception of the Umrár, all the streams become dry soon after the ending of the rainy season. And from Rocks dry. experience gained in sinking for coal, the rocks do not appear to hold much water. Most of the rain that falls is evidently carried away at once, as there is a very thin capping of soil to gather it.

The total exposure of the Barákars is, as I have said before, six Area, 6 square miles. square miles, the greatest length being four miles, and the average breadth one and a half. The boundaries cannot be very closely and accurately defined, as the sections are not Boundaries. open enough for this purpose. I have, however, mapped them as suggested by the evidence that was available. The contacts with the upper and lower groups are all natural. The Tálchirs are overlapped, where the Barákars rest upon the metamorphic rocks of the Lóra inlier, and the Barákars themselves are irregularly overlaid by newer Góndwána groups.

To the south-west of Umaria, the lower limit of the group is fairly recognisable, and the borings near the railway track indicate that the lines shown on the map are passably accurate. Near Chatán and Lál-púr there is more satisfactory ground, in the clearer views obtainable of the beds, for belief in the correctness of the limitation adopted. To the east of Umaria, however, and within the Kálésar holding, there is a broad margin of uncertainty, as the surface soil effectually hides everything from view. While opportunity offered, I had three borings put down in order to test the extension of the coal measures in that direction, but unfortunately a series of mishaps prevented their completion, and the question is still an open one as to how far eastward the boundary ought to be placed.

There is no continuous section showing the arrangement of the group, but a very fair idea of the stratigraphical sequence may be obtained

by following the course of the small stream¹ between Koilári and Má-róhi downwards to its junction with the Umrár, and then onward in the latter river to Kálésar, Umaria and Lálpúr.

The lowest bed of the Barákars in the rivulet referred to is a slightly ferruginous-tinted, felspathic silicious sandstone. Rock section.

Above it is a thin band of coaly shale, and then a succession of laminated sandstones, argillaceous blue carbonaceous shales and thicker bedded sandstones, some of which are fine-grained, faintly salmon-coloured, slightly micaceous rocks. Near the temple of Dévi, and higher in the series, is a seam of coal of very good quality, but measuring only 14 inches, which puts it out of consideration in an economic summary. The dip is N.N.E. at a low angle of 5°. At the elbow of the stream, above its junction with the Umrár, are some slightly carbonaceous grey argillaceous shales, in which the fossils were found that determined the true age of the Umaria measures. Then follow thick-bedded light grey tinted sandstones, flushed with a pinkish hue and stained in portions on the outside rusty yellow. In the Wardha Valley field this colouring would have been the peculiar mark of the Kámthi series, but in the Rewah Góndwána basin it has no specific significance.

These sandstones, with a varying proportion of calcareous matter, are

Sandstones constitute mainly of the ordinary slightly nodular, felspathic, about 200 feet. silicious type of coal-measure sandstones, and constitute about 200 feet of the Barákar group. They are deeply eroded near the village of Kálésar, and the Umrár flows through a short but pretty gorge, where an excellent view of the rocks may be obtained. Intercalated with these sandstones are the various carbonaceous layers that give value to the Umaria coal-field.

In the Umrár river, however, only one seam is visible, and the reference that I have just made in the plural number is due to the light thrown upon the constitution of the field by the various borings.

¹ A temple dedicated to Dévi, one of the wives of Shiva, has been erected on the bank of this stream, where it is reported that a seam has once been on fire. I saw no sign of such an occurrence.

From Kálésar to the upper boundary of the Barákars between Umaria and Lálpúr, only sandstones are seen, at intervals of varying distances. They differ but slightly from those already alluded to; the highest beds are grey and pinkish coarse-grained felspathic sandstones partly decomposed and with thin lenticular shaly layers. To these succeed the red and other coloured clays of the supra-Barákars, from which the village of Lálpúr is probably named.

Though there are several different courses of coal, I failed to find more than one outcrop in addition to that alluded

Coal seam.

to near the temple of Dévi, and that was of the seam exposed in the Umrár at the southern water-ghat of Kálésar in which quarries were eventually opened. It can be traced on the left bank of the river in a little rivulet, which is shown on the annexed map, exhibiting the environs of Umaria-Kálésar, on a scale of four inches to the mile. After extending about 200 yards to the westward, it is lost to view.

Many years have elapsed since the original discovery of this coal. The first who drew attention prominently to it was Captain Osborne,

Mr. Alexander Grant,
and Captain H. Hyde,
R.E.

the Political Agent of Rewah in 1860, and on his representation, Mr. Alexander Grant, of the East Indian Railway, and Captain H. Hyde, R.E.,

Consulting Engineer for Railways, visited Umaria and other localities where coal was stated to occur. Their recommendations were opposed to any active steps being taken to explore the field. Mr. Grant, in his report, stated—"The seam shows itself in four different places in the bed "and sides of the Umrár, a little above the village Kálésar. It is in "all about 3 feet 6 inches thick, being made up of thin layers of carbonaceous shale of different degrees of consistency and different shades of "colour, some of them being indurated, others earthy, some black and "others bluish. Amid them is one band or layer of some 6 or 7 inches "in thickness of the substance resembling coal evidently in greater "part of vegetable origin, and what we have seen to be combustible."

There was some excuse for the low estimate they formed of the value

of the Umaria seam, owing to the washed-out and dull appearance of the coal at the outcrop. but their conclusion drawn from inadequate investigation shows how dangerous it is to frame an adverse opinion of the quality of any coal until careful analysis and experiment have proved what its composition and real worth are.

Subsequently at different times the existence of the seam was again noted by some of our own officers, but no regular survey of the coal deposits of the Rewah State was instituted until the season of 1879-80. Late in May 1880, I obtained without visiting Umaria some samples of coal from a few inches below the outcrop. These were submitted to assay by Mr. Mallet, the Curator of the Geological Museum, and the average of his determinations gave a sufficiently favourable view of the quality of the coal to prompt a more searching investigation when the opportunity arose.

The figures were—

| | |
|---|-------|
| Moisture | 11.3 |
| Volatile matter exclusive of moisture | 29.4 |
| Fixed carbon | 45.8 |
| Ash | 13.5 |
| | 100.0 |

The ash was much less than I anticipated from the appearance of the samples, but the amount of moisture was high, and as it confirmed in a measure the opinion then held of the age of the coal, I deferred a closer examination until the mapping of the known areas of Barákars had been completed.

It was not until November 1881 that in the ordinary course of the general survey it came under my observation. The first field day was enough to make me suspect that the sandstones and consequently the coal with them were much older than had hitherto been supposed; and, acting on this belief, I endeavoured to obtain confirmatory palæobotanical evidence. The credit of supplying the direct proof of the

Discovery of plants by Hira Lál. horizon of the coal-measures rests with my colleague, Lála Hira Lál, who, more favoured by fortune

than myself, was the first to have his efforts rewarded by the discovery of a few plants of specific lower Góndwána age.

Recruiting the services of my personal servants, and stimulating their zeal by the promise of reward, we eventually obtained several fronds of

Glossopteris communis.

Gangamopteris cyclopterooides, var. *attenuata*.

Nöggerathiopsis hislopi.

None of the fossils were perfect specimens, as they occurred in friable slightly carbonaceous argillaceous shale, which it was difficult to handle in a satisfactory manner, but they were sufficiently distinct to enable Dr. Feistmantel to fix their genera. With the assurance that the proper place of the Umaria coal was with the true or older coal-measures of India, I had no hesitation in spending a small sum of money to clear the outcrop and obtain a clean piece of coal. Selecting an average sample from the lower portion of the seam, the percentages of ash, fixed carbon, and water showed so great an improvement on the first analysis, that I was impressed with the desirability of drawing the attention of the Rewah administration to the fact of the occurrence of true coal-measures at

Umaria, and that if arrangements could be made Borings suggested.

for practically exploring the field by boring, I should be happy to render what service I could in directing operations. Fortunately for the furtherance of my views, Captain Barr, the Political Agent of Rewah, responded cordially to my suggestions, and within a few weeks of my broaching the plan of operations, the necessary plant was purchased, and Mr. Stewart, who had previously been in charge of the Narbada trial borings, was appointed to test the various sites indicated by myself. There is no mechanical establishment in connection with our own department, and there is no such thing as a grant for independent explorations, so that, had the Political Agent for Rewah put aside my communication, it is probable that the Umaria coal-field would once more have been dropped for a period of years into the shadow of obscurity.¹

¹ It is also certain that if Captain Barr had declined to take this matter up, the Government of India would have done so on the strength of Mr. Hughes' recommendation.—H. B. M.

The first boring was commenced on the 22nd January 1882. It was Boring commenced, placed a short distance to the north of the out-22nd January, 1882. crop of the seam, and was sunk to procure information as to whether the coal thickened or thinned to the deep. It proved three bands of coal, measuring respectively 3 feet, 7 feet and 2 feet, the reading being—

| | ft. in. |
|--|---------|
| 1. Surface, soil | 1 6 |
| 2. Sandstone | 42 6 |
| 3. Sandstone, carbonaceous, shaly | 3 0 |
| 4. Shale, carbonaceous | 2 0 |
| 5. Coal | 3 0 |
| 6. Shale, carbonaceous | 1 0 |
| 7. Sandstone | 1 0 |
| 8. Coal | 7 0 |
| 9. Sandstone, carbonaceous, shaly | 9 0 |
| 10. Shale, carbonaceous | 2 0 |
| 11. Coal | 2 0 |
| 12. Sandstone, carbonaceous, shaly | 3 0 |
| 13. Sandstone, white, not gone through | 16 0 |
| <hr/> | |
| | 93 0 |

At the outcrop the main band measures only 4 feet $4\frac{1}{2}$ inches to 4 feet 8 inches, and its increase to 7 feet was a pleasant confirmation of the hope which had been entertained of its probable behaviour.

As many as 15 bore-holes were commenced before the rains put an end to the season's operations. Most of them were Bore-holes sunk within the limits of the Umaria holding, and satisfactorily indicated the occurrence of coal over a sufficiently large area to supply several million tons of fuel.

On the other side of the river, five borings were started. Two of these proved coal, but a series of misfortunes rendered the holes between Kálésar and Lálpúr useless as indicators, none of them having been completed. The question, therefore, as to what becomes of the coal in that direction is an open one, but I incline to think that the coal is there, and that, had the borings been carried deeper, they would have proved this to be the case.

It would be needless multiplication of details to allude here to each bore-hole section, but for the purpose of reference they are given in the chapter of appendices. The dates of their commencement and completion and the depth at which water was tapped have been added as items of interest; and diagrams, for which I am indebted to Mr. E. J. Jones, are attached.

The deepest hole in which thick coal was recorded was No. 7^a, ^{Deepest bore-hole,} due north of Umaria, but on the right bank of the No. 7^a, 184 feet. Umrar. Two seams respectively 13 and 11 feet separated by 25 feet of carbonaceous sandstone were passed through at 184 feet from the surface. It is possible that these measurements may not be quite exact, for the readings of coal and shale may be so influenced by the desire to tell a promising tale, that the latter is often unduly elevated to the dignity of the former; but I think it would be inconsistent to accept one journal as correct, and doubt the accuracy of another. Boring records are generally trustworthy enough to establish the broad fact of the occurrence of coal, though considerable caution is necessary when accurate discrimination of coal and shale is demanded.

The boring No. 9^a, which was really a test of No. 7^a, and put down in November 1883, was most carefully supervised and a lower seam was met, so that we may fairly accept as proved that there are two.

Considering all the facts that were established during the first stage of our practical explorations, I think it must be confessed that the labours of the Geological Survey were eminently satisfactory; coal was proved to exist in abundance, that it lay within easy access from the surface, that it thickened to the deep, and that the gradient, as shown by the horizon at which the seam was struck at various points, was low and advantageous for working.

Every circumstance was promising, and from the exceptionally commanding geographical position of the field, it required small advocacy to show that a splendid reserve of fuel had been unearthed in the Rewah State.

In order, however, to set at rest any apprehensions that prudence or

experience suggested, it was deemed well that they should be reduced to their smallest limits, and, to achieve this object, it was determined that the coal should be approached under the ordinary conditions of approved mining. There were two plans open for adoption,—either to drive an incline from the outcrop, or to sink a shaft to the seam. The second method was preferred as being in every sense more workman-like, and as affording more scope for efficiently dealing with an influx of water.

On the 11th March 1883 a pit of 10 feet internal diameter was commenced, 11th March 1883. Pit commenced, 11th March 1883. At a later date it was found necessary to open inclines from the outcrop, but this was only to meet a temporary demand for coal, while the trial pit was in progress.

As special qualifications were required for the charge of the contemplated underground expansion of our operations, Mr. Thomas Forster, who had gained his experience of colliery work both at home and in the Bengal coal-fields, was engaged as Mining Engineer.

The position selected for the pit was near bore-hole No. 8, where the section is somewhat in accord with Nos. 9 and 7^a—an upper and a lower seam of coal having been cut in each.

| | | No. 7. | No. 8. | No. 9. |
|-------------------|---|---------|--------|--------|
| Sandstones | . | 135' 0" | 93' 0" | 69' 0" |
| Coal | . | 13' 0" | 10' 0" | 10' 0" |
| Intermediate beds | . | 25' 0" | 8' 0" | 7' 0" |
| Coal | . | 11' 0" | 7' 0" | 6' 0" |

The depth of the shaft was calculated at 108 feet, and the sinking did not seem a very formidable task. It was not completed, however, until May 1884. During the sinking there was no difficulty in dealing with the water, a pair of ordinary buckets being quite sufficient to keep the pit dry; but the moment the coal was reached, a rush took place, and though baling was kept up unremittingly day and night, it overpowered the means we had at our disposal, and the pit was abandoned until more efficient power could be applied.

I had a strong wish to go further to the deep towards No. 9 bore-hole, but I was at first deterred by the dread of water, and the possibly heavy outlay that would have to be incurred for pumping machinery. In an untried field, it is impossible to gauge the water difficulty, and I selected the spot for the trial shaft, where I anticipated the least amount of inconvenience on this score. While it was being proceeded

Second shaft. Com. with, my original desire to open out the site of commenced December 1883. No. 9 bore-hole was carried into effect; but, without any extra machinery to combat the anticipated influx of water, it was looked upon as rather a hopeless undertaking. Strange to say, however, the measures in this part of the field were unusually dry, and the coal was reached just before the close of the past season without any other difficulty to overcome than occasional scarcity of labour.

There was not time enough to drive into the seam, so that the only objects achieved by the completion of either shaft were the procurement of more perfect samples of coal and the more exact determination of the thickness and constitution of the main seam than that afforded by the simpler method of a small boring. Seven feet of clear good coal, free from the stone bands that are visible at the outcrop, were passed through in the second pit, and the analysis of a fair average dried piece gave the following result :—

| | | | | | | | | | |
|-----------------|---|---|---|---|---|---|---|---|--------------|
| Water | . | . | . | . | . | . | . | . | 5.46 |
| Volatile matter | : | : | : | : | : | : | : | : | 25.17 |
| Fixed carbon | : | : | : | : | : | : | : | : | 66.71 |
| Ash | . | . | . | . | . | . | . | . | 8.12 |
| | | | | | | | | | <hr/> 100.00 |

Such a certificate as this speaks for itself, and from the first analysis in 1880 to this one in 1884 there has been a conspicuous improvement; the only coals of Bengal that can surpass it are some from the Kar-harbári field.

In order to supply our own local wants and enough for a few trial runs on the East Indian and Great Indian Peninsula Quarry and inclines. Railways, a quarry was sunk on the outcrop; and

eventually an incline 6 feet high and 8 feet broad was driven in on the chance of its affording direct confirmation of the augmentation indicated by the borings. Following on this, a considerable impetus to the extraction of coal was given by the acceptance on the part of the Great Indian Peninsula Railway of a tender in March of the present year for the supply of 2,000 tons of coal. As neither of the shafts at that time had been completed, a second incline and several cross-roads were opened out, which enabled the raisings to be increased from 3 to 15 tons a day.

Throughout the workings the seam retains nearly, though not quite, the thickness that it has at the outcrop. I give for comparison the following measurements made in the quarry and at the dip and rise ends of No. 1 incline.

Quarry (descending).

| | | ft. in. |
|-----|--|---------|
| (a) | <i>Coal</i> , bright | 0 6 |
| (b) | Stone band | 0 1 |
| (c) | <i>Coal</i> , bright | 0 6½ |
| (d) | Stony shale, dull | 0 7 |
| (e) | <i>Coal</i> , bright | 0 6 |
| (f) | <i>Coaly</i> shale, dull | 0 2 |
| (g) | Stone band | 0 1½ |
| (h) | <i>Coal</i> laminated, bright and dull | 0 4 |
| | <i>Coal</i> shale, dull | 0 3½ |
| | <i>Coal</i> , homogeneous | 1 3 |
| | | <hr/> |
| | | 4 4½ |
| | | <hr/> |

Incline No. 1.

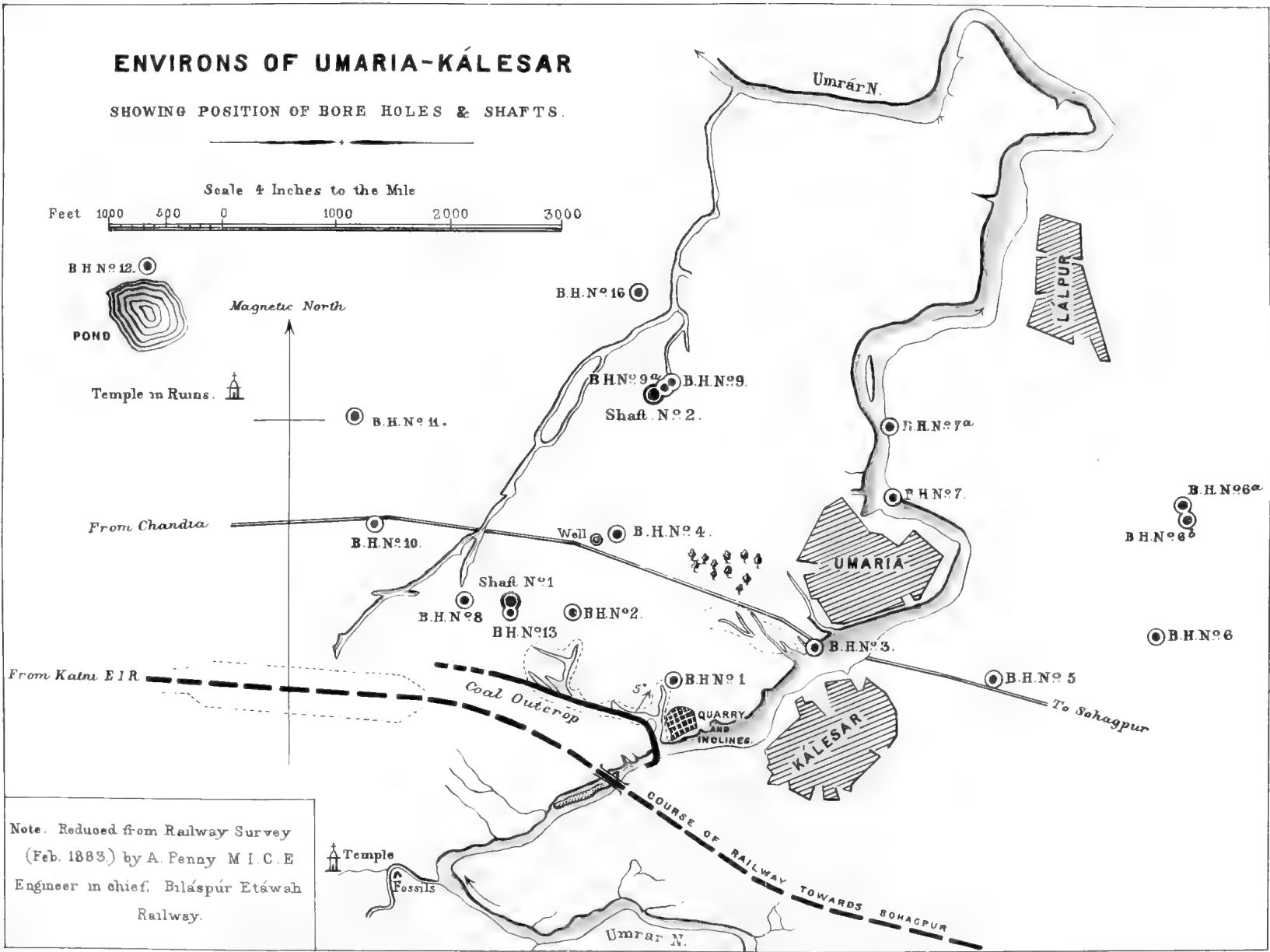
| | | RISE END. | DIP END. |
|-----|----------------------|-----------|----------|
| | | ft. | in. |
| (a) | <i>Coal</i> , hard | 0 6 | 0 10 |
| (b) | Stone band | 0 1 | 0 1½ |
| (c) | <i>Coal</i> , bright | 0 6 | 0 7 |
| (d) | Stony shale | 0 7 | 0 6 |
| (e) | <i>Coal</i> , bright | 0 6 | 0 6 |
| (f) | <i>Coal</i> , hard | 0 4 | 0 1½ |
| (g) | Stone band | 0 2 | 0 ½ |
| (h) | <i>Coal</i> | 0 5 | 2 0 |
| | Carbonaceous shale | 0 4 | |
| | <i>Coal</i> | 1 3 | |
| | | <hr/> | |
| | | 4 8 | 4 8½ |
| | | <hr/> | |

ENVIRONS OF UMARIA-KALESAR

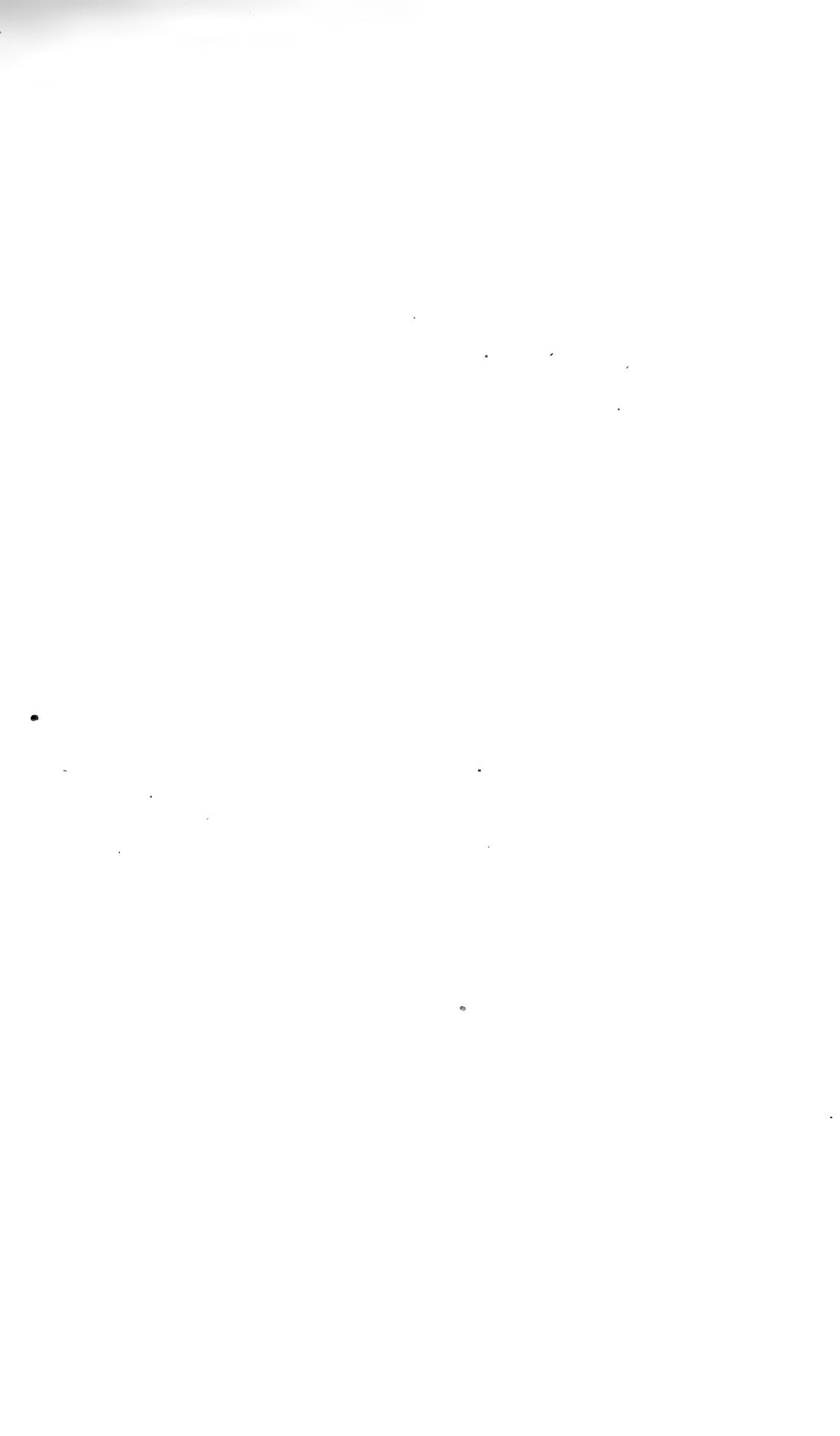
SHOWING POSITION OF BORE HOLES & SHAFTS.

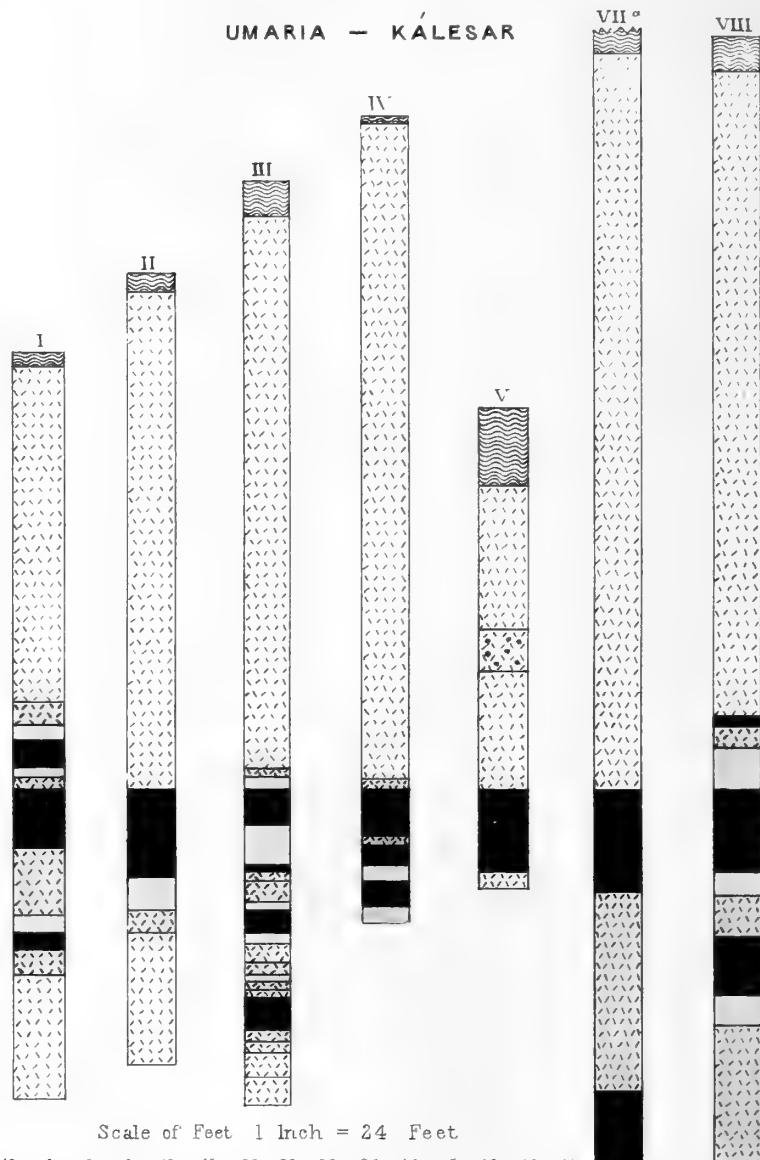
Scale 4 Inches to the Mile

Feet 1000 500 0 1000 2000 3000



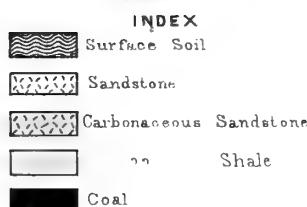
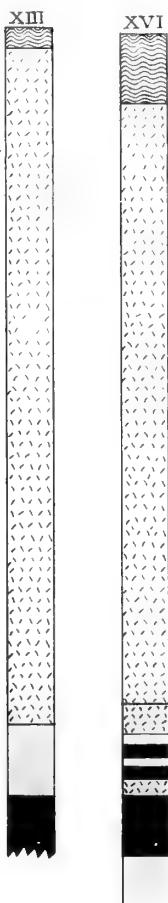
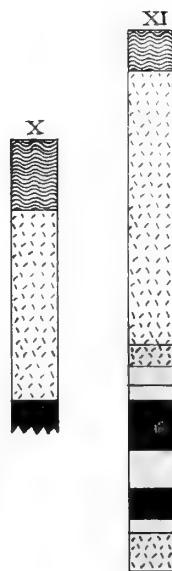
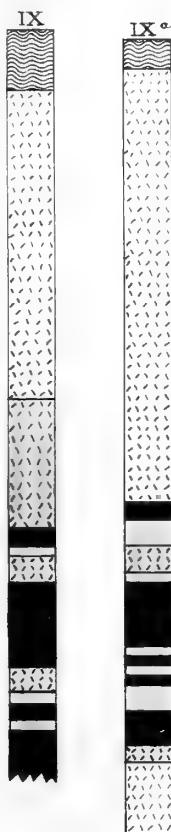
Note. Reduced from Railway Survey
(Feb. 1883) by A. Penny M.I.C.E
Engineer in chief, Bilaspur Etawah
Railway.

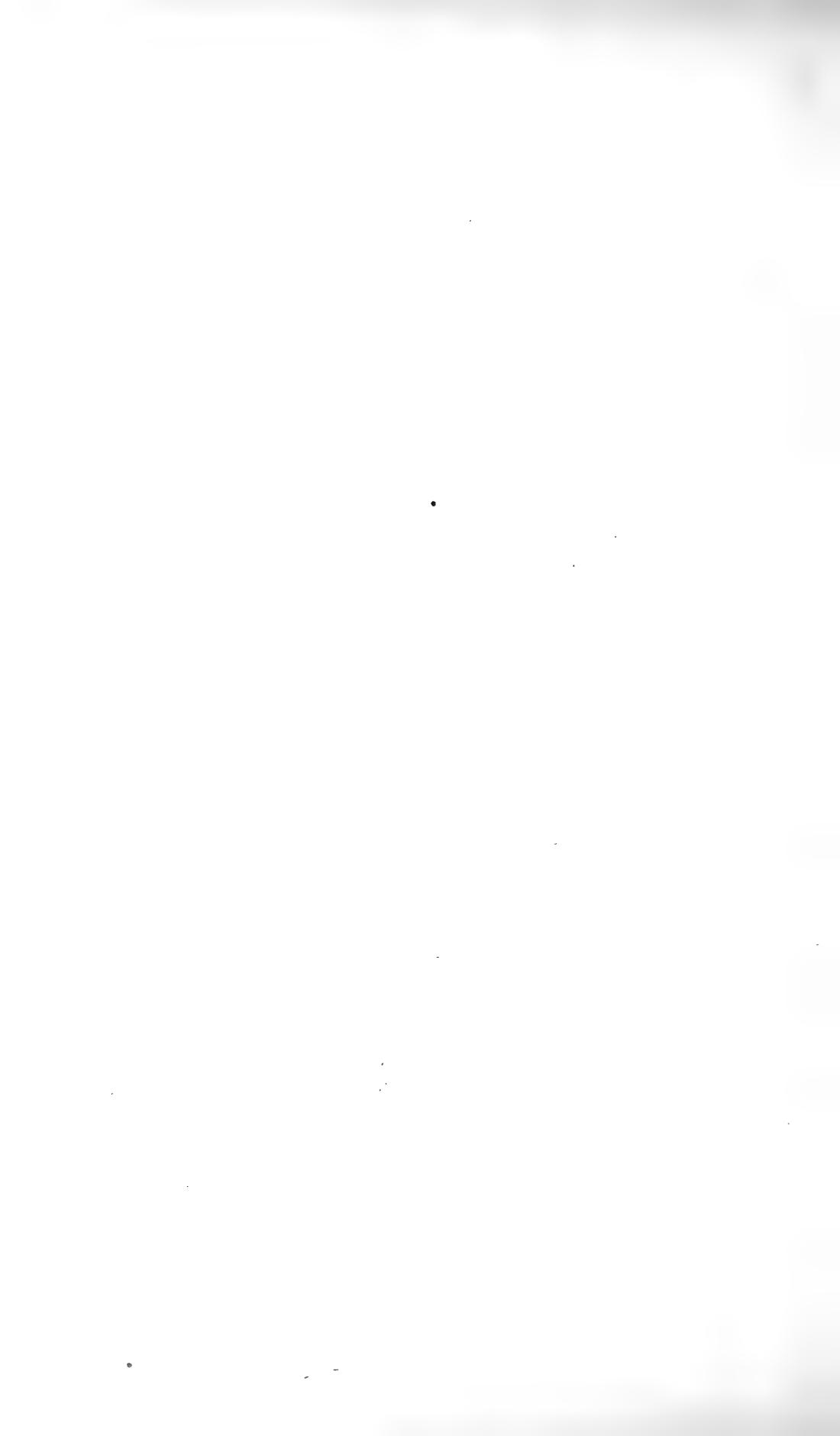


SECTIONS OF BORINGS
UMARIA - KALESAR

SECTIONS OF BORINGS

UMARIA — KALESAR





The roof is a tough, strong carbonaceous shale, and in appearance
 Roof good. is not unlike the *d* band. It has stood excellently,
 to support it. and not a single piece of timber has been required

The dip is very low, which is a favourable point in the estimate of the
 Dip low. value of the field, scarcely rising above 4° in the
 inclines. Its direction is nearly north-east.

The quality of the coal wrought in the quarry and in the inclines
 has been strongly tested under various conditions, but I intend reserving
 my full remarks as to its effective character for the Economic chapter of
 this memoir.

In anticipation, however, I may observe that the lowest 2 feet and
 Band *d*, clinkers. the bright coals constitute the best portion of the
 seam; and that the hard band *d* would have to
 be picked out, as it readily forms clinker.

The area over which coal has been proved may be accepted as $1\frac{1}{4}$
 Proved coal area $1\frac{1}{4}$ square miles, but it will be quite legitimate
 square miles. to assume that the underground extension of
 the measures in the direction of their exposed dip will give a far
 higher figure for probable coal lands. I think it quite possible that they
 extend uninterruptedly to the northward, dipping beneath the supra-
 Barákars and appearing again, as the Kórár coal-field. With reference to
 the Jóhilla Valley, I scarcely like to venture even an opinion; the
 distance between the two coal-fields is 12 miles, and the intervening
 stratigraphical evidence is altogether too meagre to make any statement
 on the subject of their continuity other than an idle guess.

SECTION VIII.—THE KÓRÁR COAL-FIELD.

The next outlier of Barákars to be described is 3 miles from the
 nearest margin of the Umaria coal-field and to the north of it. It has,
 in default of a better name, been alluded to in our manuscript reports as
 the Kórár field. There was no natural feature distinctive enough to
 suggest a title, and so the village nearest to the locality where coal was
 most conspicuously exposed was adopted as the distinguishing appellation.

Its total area is $9\frac{1}{2}$ square miles, forming an irregularly shaped crescent around the north-eastern prolongation of Area $9\frac{1}{2}$ sq. m. the Lóra metamorphic inlier. The boundaries of the Barákars are fairly well seen, and the supra-Barákars are too distinct in character to leave any doubt as to their identification, so that the separation between them and the coal-measures is easy.

Several streams traverse the field, and one of them is the Umrár. Its River Umrár. confluence with those flowing from Baréri, Múrgúri, Gagrár, and Damokar marks the upper limit of the Barákars.

The major portion of the field has been cleared of jungle, but adjoining it there are several plots of underwood, and more especially to the north of Dudraunri. Near at hand are the Forest reserves. reserves of the English Forest Department, coincident for some distance with the boundary of the Rewah State. I have no doubt that they can furnish some useful timber, and this will be a convenience of no small consideration when a colliery is started.

There are numerous sections of the Barákars, but the most complete views of them are in the neighbourhood of Kórár, Dudraunri, and Achala. The rocks consist of grey and yellowish somewhat porous felspathic sandstones, occasionally micaceous and sometimes calcareous, associated with beds of carbonaceous shales and coal. A large sheet of trap, varying in width, runs nearly the entire length of the field, and there is an inlier of the Tálchir group between Kótalwár and Khaira. The general dip is to the north.

Notice of the existence of coal in the Kórár field was originally brought to us when encamped at Baréri by the landlord of Bardauha, but it was not professionally confirmed until my colleague, while tracing the boundary of the trap eastward of Táli in December 1882, saw and mapped the different seams.

There are several outcrops, but there is only one main carbonaceous horizon, as in the case of the Umaria field.

The most westerly exposure is to the east of Achala in the Umrár at Achala. The village water-ghát. Two small bands show in the banks of the river; and in order to find out whether they increased in thickness to the dip, directions were given to Mr. Munsch, the Assistant Mining Engineer of the Rewah Explorations, to carry out a boring (1884). In this instance there was no improvement either in the quantity or quality of the bands, and after going down 181 feet the rods were shifted to a more promising locality. The rocks passed through were—

| | ft. in. |
|--|----------------|
| 1. Sandstones, brown, grey, and yellow | 58 0 |
| 2. Carbonaceous shale and sandstone | 2 0 |
| 3. Carbonaceous shale and <i>coal</i> | 4 0 |
| 4. Sandstone with pyrites | 10 0 |
| 5. Shale with <i>coal</i> | 2 0 |
| 6. Blue shale | 1 0 |
| 7. Sandstones | 52 0 |
| 8. Grey shale with <i>coal</i> | 2 0 |
| 9. Sandstones, &c. | 50 0 |
| TOTAL | . 181 0 |

South-west of Dudraunri, and about three-quarters of a mile from it, a bed of coal and carbonaceous shale occurs near the boundary of the trap; it may be better than it looks, but its appearance at the outcrop did not impress me favourably.

After the failure at Achala, borings were commenced at Jawála Múkhi, a locality in the jungle between Kótalwár and Kórár; and here very gratifying results were attained. A seam was known to occur, and it had already been mapped and reported on (1883); but whereas at its outcrop the section only disclosed

| | ft. in. |
|----------------|---------------|
| Shale | 4 0 |
| <i>Coal</i> | 2 0 |
| Shale, parting | 0 6 |
| <i>Coal</i> | 1 6 |
| | (167) |

the real thickness as demonstrated by the borings was much more—

| No. 1. | ft. in. | No. 3. | ft. in. |
|---|---------|---|---------|
| 1. Sandstone | 6 0 | 1. Brown surface soil | 3 0 |
| 2. Sand with gravel | 3 0 | 2. Sandstone | 42 0 |
| 3. Sandstone | 3 0 | 3. Sandstone, carbonaceous, shaly | 3 0 |
| 4. Coal | 8 0 | 4. Coal | 7 0 |
| 5. Shale, carbonaceous, with coal | 3 0 | 5. Shale, carbonaceous | 6 0 |
| 6. Coal | 4 0 | 6. Sandstones, grey | 2 0 |
| 7. Shale, carbonaceous, with coal | 2 0 | | |
| 8. Coal | 4 0 | TOTAL | 63 0 |
| 9. Shale | 8 0 | | |
| 10. Sandstone | 62 0 | | |
| 11. Shale | 8 0 | | |
| 12. Sandstone | 11 0 | | |
| | <hr/> | | |
| TOTAL | 122 0 | | |

The angle of dip varies from 8° to 10° . Direction north-north-west.

High percentage of fixed carbon. A sample of weathered coal gave most excellent results, and I would draw special attention to the high amount of fixed carbon.

Analysis :—

| | | |
|--|-----------|--------|
| Moisture | | 5·04 |
| Volatile matter, exclusive of moisture | | 12·56 |
| Fixed carbon | | 65·48 |
| Ash | | 16·92 |
| | <hr/> | |
| | | 100·00 |

Although the outcrop of this seam can only be traced for a short distance at the surface, there is no misgiving in my own mind of its general extension to the northward and in the direction of Dudraunri and Khaira. I anticipate also that it might be proved south of Táli, if borings were undertaken there. I would recommend this being done, should the desire to test the ground in the vicinity of Dirouri and thence

Coal probably occurs westward ever take a practical form. With coal near Táli. demonstrated as occurring in its usual strength at



SINGWARA

Ucherra

Nipania

Yarhi

Barbaespur

Gorat

Karaundha N.

Sahara

Chota Dargaoan

Baragaon

Beherde

Piprari

Marne N.

Bihna N.

Dhobghata N.

Khodargaoan

Marijdan N.

Uniorha N.

Dhobghata N.

Amadongri

Bara Dargaoan

Johilla R.

Coal

Coal

Coal

SOUTH REWAH GONDWANA BASIN
**JOHILLA VALLEY
 COAL-FIELD.**

Scale 1 Mile = 1 Inch

Furlongs 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 70 81 82 83 84 85 86 87 88 89 80 91 92 93 94 95 96 97 98 99 90 100 101 102 103 104 105 106 107 108 109 100 111 112 113 114 115 116 117 118 119 110 120 121 122 123 124 125 126 127 128 129 120 131 132 133 134 135 136 137 138 139 130 141 142 143 144 145 146 147 148 149 140 151 152 153 154 155 156 157 158 159 150 161 162 163 164 165 166 167 168 169 160 171 172 173 174 175 176 177 178 179 170 181 182 183 184 185 186 187 188 189 180 191 192 193 194 195 196 197 198 199 190 201 202 203 204 205 206 207 208 209 200 211 212 213 214 215 216 217 218 219 210 221 222 223 224 225 226 227 228 229 220 231 232 233 234 235 236 237 238 239 230 241 242 243 244 245 246 247 248 249 240 251 252 253 254 255 256 257 258 259 250 261 262 263 264 265 266 267 268 269 260 271 272 273 274 275 276 277 278 279 270 281 282 283 284 285 286 287 288 289 280 291 292 293 294 295 296 297 298 299 290 301 302 303 304 305 306 307 308 309 300 311 312 313 314 315 316 317 318 319 310 321 322 323 324 325 326 327 328 329 320 331 332 333 334 335 336 337 338 339 330 341 342 343 344 345 346 347 348 349 340 351 352 353 354 355 356 357 358 359 350 361 362 363 364 365 366 367 368 369 360 371 372 373 374 375 376 377 378 379 370 381 382 383 384 385 386 387 388 389 380 391 392 393 394 395 396 397 398 399 390 401 402 403 404 405 406 407 408 409 400 411 412 413 414 415 416 417 418 419 410 421 422 423 424 425 426 427 428 429 420 431 432 433 434 435 436 437 438 439 430 441 442 443 444 445 446 447 448 449 440 451 452 453 454 455 456 457 458 459 450 461 462 463 464 465 466 467 468 469 460 471 472 473 474 475 476 477 478 479 470 481 482 483 484 485 486 487 488 489 480 491 492 493 494 495 496 497 498 499 490 501 502 503 504 505 506 507 508 509 500 511 512 513 514 515 516 517 518 519 510 521 522 523 524 525 526 527 528 529 520 531 532 533 534 535 536 537 538 539 530 541 542 543 544 545 546 547 548 549 540 551 552 553 554 555 556 557 558 559 550 561 562 563 564 565 566 567 568 569 560 571 572 573 574 575 576 577 578 579 570 581 582 583 584 585 586 587 588 589 580 591 592 593 594 595 596 597 598 599 590 601 602 603 604 605 606 607 608 609 600 611 612 613 614 615 616 617 618 619 610 621 622 623 624 625 626 627 628 629 620 631 632 633 634 635 636 637 638 639 630 641 642 643 644 645 646 647 648 649 640 651 652 653 654 655 656 657 658 659 650 661 662 663 664 665 666 667 668 669 660 671 672 673 674 675 676 677 678 679 670 681 682 683 684 685 686 687 688 689 680 691 692 693 694 695 696 697 698 699 690 701 702 703 704 705 706 707 708 709 700 711 712 713 714 715 716 717 718 719 710 721 722 723 724 725 726 727 728 729 720 731 732 733 734 735 736 737 738 739 730 741 742 743 744 745 746 747 748 749 740 751 752 753 754 755 756 757 758 759 750 761 762 763 764 765 766 767 768 769 760 771 772 773 774 775 776 777 778 779 770 781 782 783 784 785 786 787 788 789 780 791 792 793 794 795 796 797 798 799 790 801 802 803 804 805 806 807 808 809 800 811 812 813 814 815 816 817 818 819 810 821 822 823 824 825 826 827 828 829 820 831 832 833 834 835 836 837 838 839 830 841 842 843 844 845 846 847 848 849 840 851 852 853 854 855 856 857 858 859 850 861 862 863 864 865 866 867 868 869 860 871 872 873 874 875 876 877 878 879 870 881 882 883 884 885 886 887 888 889 880 891 892 893 894 895 896 897 898 899 890 901 902 903 904 905 906 907 908 909 900 911 912 913 914 915 916 917 918 919 910 921 922 923 924 925 926 927 928 929 920 931 932 933 934 935 936 937 938 939 930 941 942 943 944 945 946 947 948 949 940 951 952 953 954 955 956 957 958 959 950 961 962 963 964 965 966 967 968 969 960 971 972 973 974 975 976 977 978 979 970 981 982 983 984 985 986 987 988 989 980 991 992 993 994 995 996 997 998 999 990

INDEX.

| | |
|---|-------------|
|  | Lamella |
|  | Metamorphic |
|  | Coal seam |
|  | Bore Hole |

Dip

5°



Pali

Sagrat

Gorai

Maliaguru

Kumurd

Mandoria

Hartipal

or near Táli, there would be considerable encouragement for the prosecution of further enquiries ; each point progressively fixed as coal-bearing being the presage of additional success.

The only other band of coal is north-north-east of Khaira in the Chapar Nala. It is very thin, and overlies shales. Khaira. Dip towards north.

A bed of carbonaceous shale occurs at Barbaspúr, another at Barbaspúr; Jagatpúr, Jagatpúr, and one near the junction of the Baréri and Kórár streams.

The various out-crops of coal and carbonaceous shale that have been One coal-bearing horizon. alluded to do not imply that there are several independent seams or bands. The exposition of the Umaria measures is to my mind a fair gauge of the structure and composition of the Kórár coal-field, and hence we may assume that there is one main coal-bearing horizon with a like minimum thickness of workable coal.

SECTION IX.—THE JÓHILLA COAL-FIELD.

The Barákars of the Jóhilla valley are exposed about 13 miles south-east of Umaria, and constitute two separate tracts, one to the north, and the other to the south of the metamorphic exposure of Pónri. By far the larger of the two, and the only one important from an economic point of

Map of north portion of Jóhilla field—scale 1 inch to 1 mile. view, is the northern area. In consequence of this circumstance I have not thought it necessary to prepare a map of each of them on an enlarged scale.

The accident of position has caused much more attention to be devoted to the Umaria than to the Jóhilla field ; but at the outset of the Rewah coal explorations, not knowing what the fate of our purpose at

Borings to prove coal. Umaria might be, a few borings were simultaneously carried out in the Jóhilla valley with the object of testing the value of the signs of coal that were there visible. The extra distance would have been a very small drawback if the only alternative of procuring coal had been the opening up of that part of the district. As events have shown, there was no immediate

necessity to have taken the precaution of examining the Jóhilla valley, but nothing has been lost by the course then pursued, and it is a matter of congratulation that we have acquired definite knowledge of a further and extremely valuable stock of coal land.

The rise of the Jóhilla river has already been described as being in the high trappean plateau of the Mandla District. Jóhilla river.

It passes by a succession of descents into the lower level of the Singwára division of the Rewah State, and, after winding through a narrow valley known as the Kbóli, which formerly enjoyed, and even now, though in a less measure, an inviting reputation as a splendid tiger-ground, exposes near Lakhánpúra, $81^{\circ} 6'$ E. Long., and $23^{\circ} 17'$ N. Lat., the thin strip of Barákars that forms the south portion of the Jóhilla valley coal-field. At Mangthár it passes through Tálchirs, and then soon after enters the metamorphic area of Pónri, the rocks of which constitute its channel for 2 miles. A little to the north-east of Pónri, it strikes the southern boundary of the Tálchirs connected with the northern division of the Jóhilla coal-field, and then, flowing past Bara Cháda, offers from that point to its union with the Són, the most typical section of the Barákar and supra-Barákar rocks that can be found in the whole district.

I think it unnecessary to defend the propriety of the designation Jóhilla coal-field. There are no other exposures of the Barákar group than those already alluded to; and as the southern area requires only a brief notice, it may be dismissed in a few words.

South area.—Jóhilla Coal-field.

The measurement of its area gives $3\frac{1}{4}$ square miles, which is a magnitude quite enough to make it a valuable field, if Area. coal occurred in workable thickness.

There are no out-crops, however, of any promise, and though I have No out-crops of any quoted several instances, as warnings against forming promise. a damning opinion on the mere evidence of out-crops, I am now speaking with the knowledge acquired in the

Umaria and Kórár fields. There, the main coal occurs well up in the measures, but the difference here, so far as I could judge, lies in the circumstance that the rocks are all below that horizon.

I would not discourage any who may, years hence, wish to satisfy their own expectations, and the following is a Localities of out-crops. statement of the few places at which there are slight signs of carbonaceous matter.

(a) South of Amuári, where the road from that village to Lakhán-púra crosses the Jóhilla, there is the following Amuári. section (descending) :—

| | ft. in. |
|---|---------|
| Thick-bedded grey sandstone | 20 0 |
| Thin lenticular band of <i>coal</i> and <i>carbonaceous shale</i> | 1 0 |
| Micaceous sandstone | 4 0 |
| Grey and carbonaceous shale | 4 0 |
| Sandy micaceous shale | 8 0 |

Dip north-north-west

(b) Half a mile south of Mangthár, on the right bank of the Mangthár. Jóhilla, a thin bed of coal and carbonaceous shale, 2 feet thick, crops out.

From this place, as also Amuári, fossils were procured, which Dr. Feistmantel determined to be¹—

Gangamopteris cyclopterooides.
Nöggerathiopsis hislopi.

(c) Some carbonaceous shale is exposed west of Mangthár in one of the small streams having no name, but in which there are several salt-licks.

There may be a possibility of finding the thick coal under the Lamétas of Isúnpúra and Taktai; but to search for it will be a speculative undertaking, and one quite unnecessary, so long as the more conveniently situated seams of the northern area and those of Umaria and Kórár are not exhausted.

¹ *Palæontologia Indica*, 1883, Ser. XII, Vol. IV, p. 14.

North area.—Jóhilla Coal-field.

This portion of the coal-field extends over an area of $11\frac{1}{2}$ square miles distributed on each side of the Jóhilla river and forming a band of varying width between the Tálchirs and the supra-Barákars.

The attention of several previous observers appears to have been drawn to the fact of the occurrence of coal in the Jóhilla valley. This is probably due to the conspicuous manner in which the coal is exposed, and its propinquity to Páli, one of the usual and most favourite halting-places *en route* to and from Sohágpúr.

For travellers progressing eastward, Páli is the last village at which supplies can be procured; and there is a great temptation to steal a day in one's programme of marches to enjoy the shady mango groves, the beautiful prospect, and the wild duck and snipe-shooting that the large tank and rice-runs afford.

In 1840 Dr. Spilsbury, in the *Journal of the Asiatic Society of Bengal*,¹ mentioned coal as being found in the bed of the Jóhilla river near Páli, and likewise in a small stream near Kálésar-Umaria of Rewah. At that time the Sing-

Jóhilla valley formerly under English rule. wára, and the whole of the Jóhilla coal lands were under English domination, but after the Mutiny they passed, together with the Sohágpúr táluk and the shrines of Amar-kantak, into the hands of the Rewah administration. In 1854 Major

Major Wroughton, Mr. Grant, Captain Hyde, 1854—1860. Wroughton stated that coal occurred in the Jóhilla. In 1860 Mr. Grant and Captain Hyde, of whom mention has already been made, passed by the Jóhilla in the belief that the coal was no better than that of the Umrár river. In the same year Mr. J. G. Medlicott inserted, in the *Memoirs of the Geological Survey of India*, Vol. II, Part 2, a short paragraph concerning coal near the village of Maliágúra, and mentions that it was

¹ *Journal, Asiatic Society, Bengal, Vol. IX, Part 2, p. 903.*

light and very bituminous. The subsequent notices of the Jóhilla valley are those by myself in the Records of the Survey.

The boundaries of the Barákar group are fairly well discernible, and the only indeterminate portion is near Kúmúrdú, where alluvium and rank grass frustrate all attempts at close delimitation.

There is very little departure from the ordinary type of sandstones in any of the river sections; but in that of the Dhóbgátha I remarked some yellowish felspathic silicious sandstones near Khodárgaon, with

thin vitreous ferruginous plates and containing Ferruginous sandstone. pebbles. It goes against my previous experience to place such beds either in the Rániganj or Barákar divisions of the Damúdas, but immediately above them is a grey earthy shale, coloured here and there by carbonaceous matter, in which fossils of true Barákar type, of the genera *Glossopteris* and *Vertebraria*, were found, and I have, in consequence, accepted the evidence as decisive of the horizon.

In the Ganja Nala, where the road from Páli to Maliágúra crosses Ganja Nala. it, sandstones very similar to those in the Wardha valley may be seen on either side of the ford. They are nodular, texture granular, felspar slightly decomposed, and colour either somewhat yellowish-grey or reddish-grey.

The general dip is to the north and at low angles.

Coal occurs in several places, but just as in the other fields there is only one main horizon, so the same feature is Outcrops. repeated here. The most noted out-crop is that in the Jóhilla river, where the Ganja Nala joins it. A shallow boring (1882) was sunk on it to get a fair reading of the Jóhilla boring. general thickness of the seam, and the result showed a great advance on my measurements at the surface.

As a point of interest I place the two sections side by side:—

| | ft. in. | | ft. in. |
|---------------------------------|---------|--------------------|---------|
| No. 2 Jóhilla Valley Bore-hole. | | Surface section. | |
| 1. Dark surface soil | 1 0 | | |
| 2. Sandstones | 5 0 | Sandstones | ... |

(173)

| | ft. in. | Surface section. | ft. in. |
|---|---------|-----------------------------------|---------|
| No. 2 Jóhilla Valley Bore-hole. | | | |
| 3. Coal | 17 0 | Coal and coaly shale . . . | 12 0 |
| 4. Sandstone | 1 0 | Grey micaceous sandstone . . . | 5 0 |
| 5. Carbonaceous shale | 6 0 | Coal and coaly shale . . . | 6 0 |
| 6. Carbonaceous shale and sand- stones | 12 0 | Argillaceous shale . . . | 2 0 |
| 7. Coal | 6 0 | Coal and carbonaceous shale . . . | ... |
| 8. Carbonaceous sandstone | ... | | |

The seam can be traced both east and west, and a bore-hole was put down (1882) near the junction of the Marjada and Marjada boring. Umarha streams, where the coal appears in great force. The section agrees closely with that of the Jóhilla boring—

| | ft. in. |
|--|---------|
| 1. Yellow clay | 1 0 |
| 2. Sandstone and shale | 15 0 |
| 3. Carbonaceous clay and shale | 11 0 |
| 4. Sandstone | 7 0 |
| 5. Coal | 17 0 |
| 6. Carbonaceous and grey shaly sandstone | 2 0 |
| 7. Coal | 3 0 |
| 8. Carbonaceous shale and sandstone | 5 0 |
| 9. Coal | 8 0 |
| Sandstone and carbonaceous shale— | |

Angle of dip is 6°, direction nearly due north.

From this point westward I failed to procure further evidence of the existence of this seam, but I have strong faith in its extension, and also that, when circumstances render it a matter of importance to follow it up, it will be found to occur under the Lamétás of the Marni Nala.

For the purpose of having the coal practically tested, 500 maunds Coal quarried for trial were quarried from the out-crop in the Marjada on railway. Nala and delivered to the Great Indian Peninsula Railway for trial in their locomotives.

Average samples selected by myself gave excellent percentage figures, and for comparison with those of Umarha coal I append a few analyses of each.

| | Vol. matter. | Fixed carbon. | Ash. |
|-------------------|--------------|---------------|-------|
| Marjada | 32.31 | 54.58 | 13.11 |
| ” | 35.60 | 52.77 | 11.63 |
| ” | 36.64 | 55.93 | 7.43 |
| Umarha | 26.70 | 59.20 | 14.10 |
| ” | 26.40 | 60.90 | 12.70 |
| ” | 28.40 | 60.70 | 10.90 |

I believe that in the running trials the Jóhilla coal was stated to have shown a slight superiority, but it is difficult to reconcile this assertion with the deduction to be drawn from the analyses.

Considering the distinct advantage in fixed carbon possessed by the

Umaria and Jóhilla coal, the latter ought to have been the coal probably alike in quality.

Umaria coal, the latter ought to have been the better fuel.

Eventually, when both seams are cut into, under a moderate amount of covering, I

have no doubt that they will give very even returns. There is sulphur in all the coal.

A third boring marked on the map as III was instituted to prove a

Dhóbghata boring. small out-crop in the Dhóbghata Nala ; but after

going through 153 feet of successive sandstones, the rods were withdrawn, the conclusion being that the coal was ephemeral.

Below the junction of the Bichna and the Dhóbghata, there is a band of coaly shale, but no coal. In the bed under it some specimens of *Glossopteris* were procured.

In several places plants were discovered. Three species were obtained

Fossils. below the seam in the Jóhilla river—*Glossopteris*

communis, *Gangamopteris* comp. *cyclopterooides*,

and *Nöggerathiopsis hislopi*. From the Kúdri feeder of the Dhóbghata

Nala, seven species—*Vertebraria indica*, *Glossopteris communis*, *Glossopteris*

indica, *Glossopteris browniana*, *Glossopteris damudica*, *Gangamopteris*, sp.

Nöggerathiopsis hislopi. From the head waters of the Dhóbghata

stream, and not far from the village of Amádóngri, eight species—*Glos-*

spteris indica, *Glossopteris tænioides*, *Glossopteris angustifolia*, *Ganga-*

mopteris angustifolia, *Gangamopteris cyclopterooides*, *Gangamopteris sub-*

auriculata, *Samaropsis*, comp. *parvula*, *Nöggerathiopsis hislopi*.

Dr. Feistmantel points out, with reference to these forms, that they correspond to the association of fossils found with the second and third seams of the Karharbári coal-field. That there is this correspondence is clear enough, but I have hitherto failed to see anything distinctive enough in the character of the rocks containing this partial Karharbári flora to warrant a separation from the Barákar.

Before closing my remarks on the Jóhilla field, I would wish to say

Expediency of borings
to supplement researches
of Geological Survey.

that these explorations are another illustration of the expediency of supplementing our geological researches by boring operations, for, like those who

preceded me, I formed a poor opinion of the seam from the evidence at the out-crop. Greater experience of the frequent fallacy of surface indications enabled me to guard myself against expressing unequivocal condemnation, but the general bearing of my opinion was,¹ as expressed in my first contribution on this area in the Records of the Survey, that the coal was poor, and not worth much consideration. The borings and quarrying have proved that something more practical than hammer tapping is required to frame a correct estimate of the value of a seam.

It is fortunate that justice has been done to the Jóhilla valley, for, notwithstanding the fact of its coal being 13 to 14 miles further from Katni than Umaria, it will prove either a very formidable rival to that field or a seasonable reserve, according to the conditions on which the lease of the Rewah mining rights is granted.

There appears to be quite 20 feet of coal, and, although the out-crop of the seam cannot be traced for more than 2 miles, it is almost a certainty that both in the direction of Khodárgaon and of Páli shallow sinkings would touch it.

I refrain from attempting to make a close estimate of the available quantity of fuel, for there is the undefined area Estimate of quantity. under the supra-Barákars which introduces such latitude into one's figures that to my mind there is no satisfaction in treating the question. If asked, however, whether 100,000,000 tons of coal might be extracted from the Jóhilla valley down to a depth of 500 feet, I should reply in the affirmative.

¹ "Records, Geological Survey of India, 1881, Vol. XIV, Part I, p. 127,"—"I do not condemn it because experience has taught me that many seams (as in the Wardha and Móhpáni fields) with thin outcrops may thicken rapidly, and furnish a good deal of coal. I can say, however, that the signs are not promising."

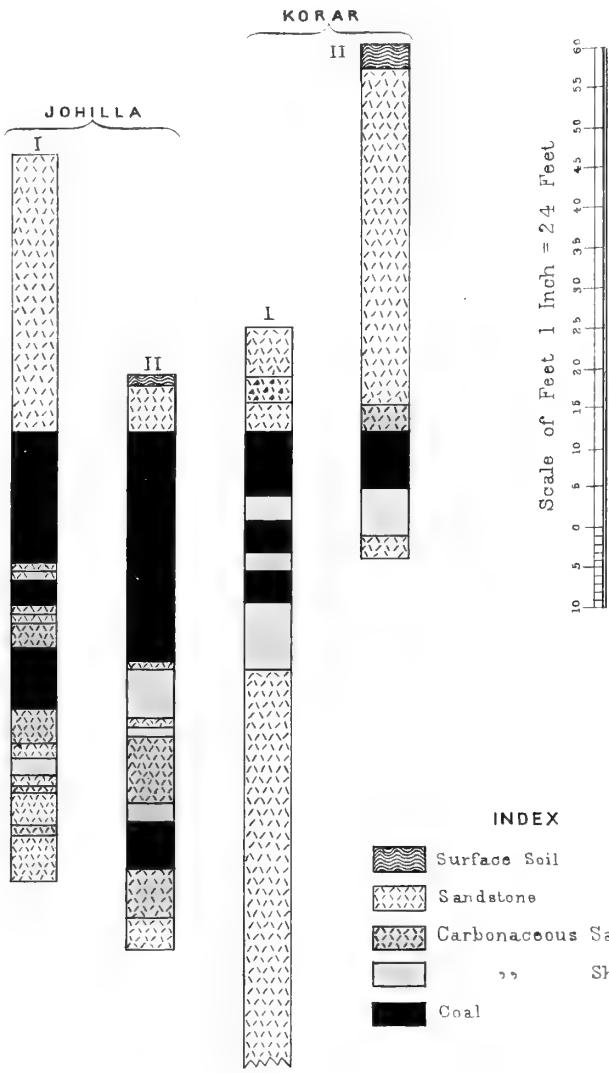
GEOLOGICAL SURVEY OF INDIA

Hughes:

Memoirs. Vol XXI Pt. 3.

SECTIONS OF BORINGS

JOHILLA VALLEY & KORAR



SECTION X.—THE SOHÁGPÚR COAL-FIELD.

From the description of the three small outlying fields, I now pass

Main area 1,600 square miles. to the notice of the more extensive main area comprising nearly 1,600 square miles, and to which

I would give the name of the Sohágpúr coal-field. It may hereafter be found convenient to introduce some restricted local designations. The portion within the Koréa district appears suggestive of such a course, but I have no doubt that the adjustment of names and titles will be satisfactorily carried out when the necessity arises.

Roughly speaking, the Sohágpúr field stretches through two degrees of longitude, from the river Són to the river Rér. There is no great

Coal seams not plentiful. richness of coal, nature having apparently exhausted herself in abortive efforts resulting in carbonaceous or coaly shale, or seams too thin, according to the present standard of working, to be mined profitably. Owing to the horizontality of the strata, however, such seams as occur of available size possess the advantage of extreme accessibility, and can be easily won over an extensive area.¹

Of the rocks constituting the Barákars of the Sohágpúr field, quite nine-tenths are sandstones, of which the major Sandstones constitute $\frac{9}{10}$ ths of group. portion are the ordinary grey or yellowish-grey silicious sandstones, sometimes earthy and sometimes slightly calcareous, with a small percentage of mica.

I have grouped the whole of the coal measures as Barákars, rather than enter upon the uncertain and equivocal task of separating them under the divisions of Karharbári, Barákar, and Rániganj. Amongst the lower strata there are fossil forms which agree with many of those found in the Karharbári beds of the Karharbári field, and in the higher strata are a few plants which were formerly esteemed as distinctive of the Rániganj horizon. Later researches, however, have shown that the range of many of the supposed characteristic fossil forms is much greater

¹ This remark applies only to the portion of the Sohágpúr field in the Rewah territory.

than was formerly supposed, and in the absence of collateral stratigraphical evidence, I have preferred to retain all the coal-bearing rocks under one denomination.

With the exception of the lowest beds of the group around Sáranpúr, Dhámni, Amiliha, and Dhirauli, there is a common type of feature in all the sandstones, until the unmistakable ferruginous sandstones of the supra-Barákars are reached. There is no representative here of the iron-stone-shales group, which, coming between the upper and lower coal measures of the Damúda valley fields, makes the separation of the Damúda series in that region a matter of extreme facility ; and though it is a fact patent to every ordinary mind that where little or no disturbance has taken place, lower beds must necessarily be older than upper ones, there is nothing sufficiently distinctive either in the distribution of the plants or the succession of the strata to call for further sub-division.

It would involve a tiresome rehearsal of a multiplicity of names Boundaries of Sohág. to describe the course of the boundaries of the púr field. Sohágpúr field. I would refer the reader to the large map ; from which it may easily be perceived that the supra-Barákar and Laméta groups are unconformable to the Barákars. Nearly throughout their entire extent the boundaries are natural, the only doubtfully faulted portion being that in the Jbilmili area, where a fault was mapped by my late colleague Professor V. Ball.¹ I was not able to make an independent inspection of this feature, but I assume that my views would have been in accord with his could I have devoted enough time to the study of the question.

Dip northerly, at low angles. There is a general dip to the north at low angles, implying very slight disturbance.

In an Appendix a list has been drawn up of all the sites at which List of coal outcrops in Appendix. coal has been noticed. It presents a formidable length, but this bears evidence rather to the fact that so far as mere plodding was concerned it was energetically carried out, and not that there is a super-abundance of coal. For such a wide

¹ It is marked in his map of the Bisrámpúr coal-field, which lies to the south-east of Jbilmili (Records, Geological Survey of India, Vol. VI, part 2).

area as 1,600 square miles, outerops were very sparingly met with, and when this fact was understood, it became an obligation to explore every stream, great and small, much more closely than was at first contemplated.

In the comparatively level expanse of the Sohágpúr district, this obligation was almost too scrupulously discharged. But in the hilly tracts and uplands of Koréa and Jhilmili, the tax on our time was too great, the streamlets and the runlets being overwhelming in number; and many of them, in which doubtless there are exposures, have consequently been unheeded.

Entering the Sohágpúr field from the west, through the picturesque Múrcha pass on the road between Páli and the town of Sohágpúr, several miles of sandstones have to be traversed, both with and across their strike, before anything like a workable seam of coal is met with.

Following the proposed line of railway as marked on our map, there are only a few thin outerops of carbonaceous matter near Máhroi, Semriha, Kaunábáhára, and Soháhpúr, which seem to me utterly devoid of promise of anything better below the surface.

The thickest of these is 2 feet, and it occurs in the Kaunábáhára stream, a short distance above its junction with the one coming from Semriha. It is much weathered at the surface. Northward from this outcrop, the sandstones are thickly bedded porous rocks with decomposed and undecomposed felspar, the former of which is of an unusually reddish colour.

Specimens of the fossil *Trizygia speciosa* together with *Glossopteris communis*, *Glossopteris formosa*, and *Vertebraria indica*, were found in some variegated micaceous shales, and greenish close-grained micaceous argillaceous sandstone, associated with the coal band exposed in the Múrna river where it flows past Sohágpúr.

This is one of the few localities in which *Trizygia* was met with. As bearing on the unification of the Damúda series, this equisetaceous plant is a very interesting one. In former years it was supposed to be a

characteristic Rániganj form, but it appears that it occurs almost as frequently in the Barákar as in the Rániganj group, as shown in the following list¹ :—

| | Rániganj group. | Barákar group. |
|----------------|-----------------|----------------|
| Rániganj field | . | * |
| Sátpúra Basin | : | * |
| Auranga field | : | * |
| Bókáro | : | * |
| Tálchir | : | * |

To the east of Sohágpúr an admixture of coal and carbonaceous shale—the latter largely preponderating—shows at the edge of the trap formation between Chainpúr and Jamúa-Jamói. The bed measures 7 feet, but did not impress me favourably as a source of coal.

It was my intention to have had three or four borings made in the neighbourhood of Sohágpúr to place our knowledge of that part of the

Borings not carried out. field on an exact footing, but unfortunately circumstances arose which necessitated the presence at

Umaria until the close of the working season (1883-84) of the Assistant Mining Engineer, to whom the task of carrying out my views had been entrusted. Neither here therefore, nor at Lálpúr, Khaira, or Dhanpúri—all villages, further to the east and south, where sites had been marked out for trial borings—have any underground readings been obtained.

Judging from the evidence available at the surface, I should not be disposed to commend the area immediately adjoining the railway from the Múrcha pass to Sohágpúr for initial mining operations in this field.

There are more decisive and cheering indications of fair coal lands in the vicinity of the Són; and as a convenient line of description to follow, I shall take the river up where it enters the Barákar area north of Anúkpúr² and comment on the outcrops in it, and near it until it passes beyond the confines of the field.

¹ Pal. Indica, Fossil Flora of the Gondwána System, Vol. III, Pt. 2, p. 71.

² Anúkpúr is the residence of the Chief of Sohágpúr.

The lowest seam is exposed between the villages of Karaibáhára and Mariáras in the Bakán Nadi, a tributary on the left side of the Són. It measures 3' 3" at the crop, but will in all likelihood thicken to the deep.

With the object of determining this circumstance, Bakán Nadi seam 3'3". and the further question of whether it was the probable representative of the Umaria band, I marked a spot for a boring near Chachai, but, for the reasons previously explained as affecting the other sites in the neighbourhood of Sohágpúr, my purpose was not fulfilled. A feeling of grateful relief, after a month's close survey, at having found anything like coal, made me at first estimate my discovery of this seam a little too highly. Referring to my field notes, I see that I alluded enthusiastically to the coal; a more moderate view gives, I think, a truer idea of its quality.

The outcrop is confined to the Bakán Nadi, as there is not a trace of it in any of the numerous streams either to the east or to the west of the Són.

I searched carefully around Mariáras for further signs of coal, but Water-borne coal in Suthná Nala. I could only find water-borne fragments in the Suthná Nala. I endeavoured to lay my hand on the bed that they came from, and spent more than a week in prospecting, without obtaining a satisfactory return for my labour.

The next stream in which there is evidence of coal is the Katna, on the right bank of the Són. In the lower portion of its course there are two outcrops near Rámpúr, but they are scarcely worth recording. In the upper reaches there are several places in the neighbourhood of Manglichúan Harri, and Manjira. where indications of coal are visible, but with the exception of a bed of inferior quality between Harri and Manjira, measuring about 6 feet, none of them exceed 30 inches.

North of the confluence of the Katna with the Són, we find a belt of productive measures, occurring at about the same horizon as that of the Umaria field. There is one main seam which is something more

Good seam of coal. than 5 feet, and two smaller ones underlying it, varying from 12 to 30 inches. Owing to gentle

rolling in the strata, and to the low dip that obtains, the outcrops of all the different beds are repeated, and we must guard against over-estimating the number of seams that we are dealing with.

The main seam comes to the surface between Bargaon and Kelhauri, Outcrops of good seam, once in the Jamúnia, thrice in the Són, frequently in the Bagéha, and twice in the Nargára stream. It covers a large and easily workable area on either side of the Són, and it can be picked up along its strike for a distance of 10 miles.

It is the seam *par excellence* of this part of the field, none other approaching it in thickness; and I am glad to see that the line of

Proposed railway line touches seam between Burhar and Amlei. railway actually touches it between the villages of Burhar and Amlei, thus making it immediately accessible to any adventurers who may wish to work it. The coal is of fair quality throughout, but that in the upper portion of the seam is the best. The assay of a sample of the latter gave—

| | | | | | | | | |
|-----------------|---|---|---|---|---|---|---|-------|
| Moisture | . | . | . | . | . | . | . | 5.8 |
| Volatile matter | : | : | : | : | : | : | : | 29.5 |
| Fixed carbon | . | . | . | . | . | . | . | 55.0 |
| Ash | . | . | . | . | . | . | . | 9.7 |
| | | | | | | | | 100.0 |

It does not cake. Colour of ash reddish-grey. I failed to trace the seam west of the Nargara river, and strange to say there is not a vestige of coal exposed in the wide tract extending from the river to the boundary of the overlying Laméta and supra-Barákar groups to the south-west. In the Sarpa Nadi, there is just sufficient coal to oblige me to allude to it, but this is north of the area indicated as sterile.

The next tributary of the Són of noticeable size below the Bagéha is the Kasér Nadi, which with its feeders gathers Kasér Nadi. the waters over a large stretch of country south of the Kúnúk river, and the irregular line of trap extending from the trap-capped hill of Mahóra. There are very few outcrops of coal within the limits of its drainage basin, and in two instances only could I make a complete measurement of their thickness. To illustrate the

character of the sections afforded by this river, I quote the remarks on my field map appended to each plotted outcrop.

| Village. | River. | REMARKS. |
|-----------------|------------------|-------------------------------------|
| Kharla . . . | Kasér . . . | Coal obscure. |
| Nimhua . . . | ," . . . | Coal under water. |
| Terriha . . . | Jamuna trib. . . | Small exposure. Only 1'6" seen. |
| Channauri . . . | Tributary . . . | Coal under water. |
| Bargaon . . . | Jamuna trib. . . | Coal under water. Difficult to see. |
| Ditto . . . | ," . . . | Shale under water. |
| Hatgala . . . | Tributary . . . | Coal and carb. shale badly seen. |
| Bahgár . . . | Kasér . . . | Coal under water. |
| Sáhipúr . . . | Tributary . . . | Coal only partly exposed. |
| Bacharuar . . . | ," . . . | Coal partly seen. |
| Daukibúri . . . | ," . . . | Not all seen. |
| Kúréli . . . | Bichli trib. . . | Seam not seen. |

The definite measurements were—

| Village. | River. | REMARKS. |
|--------------|----------------|---------------------------|
| Nimhua . . . | Kasér . . . | Coal 2' 0". |
| Kúréli . . . | Jóba trib. . . | { Coal 6". Coal 1' 6". |

The story of the Kasér is that of nearly every remaining river and stream in the Rewah portion of the Sohágpúr field, east of the Són. The seams are few in number, small in thickness, and imperfectly exposed, and it would be an infliction on the reader to devote a paragraph to each, as full justice in most instances is meted to their claim for consideration by the general designation, unimportant.

There is however one seam near Sáhipúr which, though obscured by Sáhipúr noticeable water, appears worthy of attention. It crops out seam. where a small stream east of the village joins the larger one coming from Karrabán. About 4 feet are visible, but probably 6 to 7 feet would be a nearer approximation to its true thickness.

About a mile below the Kasér is a little stream flowing from Birhúli Birhúli seam. in which there is an inferior seam measuring 3 feet, the continuation of one of those noticed above. Then for 8 or 9 miles the Són flows over a considerable mass of trap and through sedges which give the river bed an unusual appearance of luxuriant greenness.

Near Nabalpúr the Sarpa falls into the Són. This stream rises at the foot of the trappean plateau to the south, and Sarpa stream. receives a prodigious number of tributaries.

One of them between Hardi and Sárangpúr exposes a thin band of carbonaceous shale at a spot where several specimens of plants were obtained. As this is the nearest and only approach to anything like coal over a large area, I have noticed it. It has no significance, however, from an economic point of view.

In another tributary,—the Jamúna Baisaha—near Dhámni, some Fossils. very fine leaves of *Nöggerathiopsis hislopi* were procured, and in association with them were seeds of the same plant. Of these latter, which Dr. Feistmantel has named *Carpolithes milleri*, he says, that they were first described from Passerabha in the Karharbári coal-field from Karharbári beds. It is somewhat interesting to find them in such a distant region as showing the wide distribution of this particular cycad.

Enumerating the different collections of fossils from the neighbourhood of Dhámni, Sárangpúr, and Hardi under one head as they all belong to the same horizon, they comprise *Vertebraria indica*, *Glossopteris communis*, *Gangamopteris cyclopterooides*, *Gangamopteris spathulata*, *Anomozamites*, *Nöggerathiopsis hislopi*, *Nöggerathiopsis lacerata*, *Voltzia heterophylla*, *Carpolithes milleri*, *Samaropsis*, cf. *parvula*.

There is an analogy between these fossils and those from the Karharbári group, but a recent visit to Karharbári has shown that, so far as petrological and textural features are concerned, there is no harmony between the rocks of the two fields. In the strata of the Karharbári horizon, one of the points chiefly insisted on is the brecciated character of the sandstones. Those of this region are peculiarly devoid of pebbles either worn or sharp; they are principally soft earthy sandstones and shales occasionally micaceous, moderately fine-grained, and either whitish or grey dashed with pink or brown.

Passing the neighbourhood of Khaira, the Sarpa and its affluents

No coal outcrops near Khaira. cut through typical felspathic Barákar sandstones, but, strange to say, I could not find a trace of coal or any approach to coal. So much, however, was I struck with the probability of its occurrence, that I chose two sites for boring; one between

Sites for boring. Khaira and Pipária, and the other at the junction of the Barúa and the Sarpa streams. As I have previously explained, however, these borings were not carried out, but should explorations ever again be thought necessary, I recommend them as suitable positions.

The only outcrop of coal of any pretension in the Sarpa is near the southern margin of the trap area north of Lálpúr seam. Lálpúr. It is better seen east and west of the river in two small streams and the section is (descending)—

| | ft. in. |
|------------------------------|---------|
| Carbonaceous shale | 4 0 |
| Coal | 2 0 |
| Carbonaceous shale | 3 0 |

I am inclined to believe that this seam corresponds with the shale and coal east of Sohágpúr along the border of the traps between Chainpa and Jamúa-Jamói, and perhaps if driven into, the proportion of coal at both places may be found to be actually greater than appears at the surface.

North of the Sarpa we find in the Són another outcrop of what struck me at first as being mainly carbonaceous or coaly shale, but it is

evidently the continuation of a large seam that is very plainly exposed in the Nagaua and Jamúniha streams, and which, when accessible for examination and measurement, proved to be a useful collection of coal.

The full section is best seen where there is a waterfall in the Jamúniha north of the village of Nandnah, and Nandnah seam. the several dimensions are as follow:—

| | | ft. in. |
|-----|---|---------|
| 1. | Fine-grained grey felspathic sandstones. | |
| 2. | Fine-grained slightly carbonaceous micaceous sandstones | 2 8 |
| 3. | Carbonaceous shale | 2 0 |
| 4. | Coal | 5 0 |
| 5. | Carbonaceous sandy shale | 5 0 |
| 6. | Coal | 0 2 |
| 7. | Shale | 0 3 |
| 8. | Coal | 4 6 |
| 9. | Carbonaceous shale | 4 0 |
| 10. | Coal, hard | 3 6 |
| 11. | Carbonaceous shale | 1 0 |
| 12. | Ironstone (this is a distinctive band) | 0 8 |
| 13. | Carbonaceous sandy shale | 0 9 |
| 14. | Sandstone. | |

This seam can be traced over a very large area, and I am of opinion that it appears again in the north in the Khairi and Kúnuk rivers. I make this statement, however, with some diffidence, as the section across country, although suggestive of this, is not a clear one. Analyses of coal from the bands numbered four, eight, and ten give the following results (*exclusive of water*):—

| | Volatile matter. | Fixed carbon. | Ash. |
|-------|------------------|---------------|-------|
| No. 4 | 23.84 | 62.50 | 13.66 |
| „ 8 | 26.55 | 62.89 | 10.56 |
| „ 10 | 18.28 | 48.15 | 33.57 |

The better portions 4 and 8 are said to cake and partially cake, and as the samples represent the worst quality of their respective bands, having been taken from where the coal has undergone deterioration by exposure to alternating heat and rain, we may confidently commend this seam as a valuable item in appraising the merits of this part of the Sohágpur field.

Higher in the series are two or perhaps three small beds of coal, Small seams in various rivers. the outerops of which have been met with in the Nagaua and its tributaries, and also in the Ghorbei, Gurrha, Kanuahi, and Khairi streams. Not one of these strikes me as being of much importance; the greatest thickness in no case exceeds 3 feet 4 inches. Several of the outerops are at the Seams at base of waterfalls. base of waterfalls, and whilst our survey was progressing, this connection of coal with each abrupt fall in the level of the rivers was found to be of constant occurrence; during the later years of our labours, we took advantage of this circumstance to diminish the toil of speculative wandering.

I am inclined to think, as I have already said, that the Nandnah seam crops out at the mouth of the Khairi and Kúnuk rivers, but the sections are very imperfect. The first one, just at the junction of the Khairi with the Són, when roughly measured, gave (descending) —

| | ft. in. |
|--|---------|
| Thick bedded sandstone | 17 0 |
| <i>Coal</i> inferior | 1 10 |
| Blue shale | 0 5 |
| <i>Coal</i> inferior | 3 0 |
| Blue shale | 1 10 |
| <i>Coal</i> | 2 0 |
| Carbonaceous and shaly sandstone | 7 0 |

Some of the coal was submitted to examination in the laboratory, but the results obtained were not encouraging.

In the Kúnuk, the seam is but partially seen, and the exposure is 4 feet 9 inches to 5 feet. It cannot be traced far, and in all directions there is a great abundance of trappean matter, which covers up the rocks.

Of the small seams higher in the series on the right side of the Són, there are representatives or the actual continuations on the left side of

Outcrops near villages Semdih, Maiki, Kushai, Kathari, Nipanian. the river within the holdings of the villages of Semdih, Maiki, Kushai, Kathári, and Nipanian.

Not one of them exhibits a greater thickness than 2 feet 6 inches. The dip varies, being both to the north and south, but the angle throughout is small, only very occasionally rising to 8 degrees.

Passing again to the other side of the Són, three coal bands occur in the Singaora and Silpari and Diápipar streams. Outcrop in Singaora, Silpari, and Diápipar streams. The largest of these is at the outfall of the Singaora into the Són at the bottom of a small cascade ; but like the rest it seems to promise nothing of practical value.

In the actual bed of the Són, there is no sign of coal for many miles down its course beyond the junction of the Singaora Nala, until the village of Gúrárú is reached ; but in the Múrna river, which was alluded to when describing the neighbourhood of the town of Sohágpúr, there is an outcrop between the hamlets of Udri and Bijauri. I could not in any of my measurements make the thickness more than 5 feet, and the quality struck me as being poor, pieces of the coal being very heavy. One of the exposures is at the base of a small waterfall at the mouth of a rivulet joining the Múrna, and while examining it I disturbed a fine male tiger (which I subsequently shot) that had retired for the day to the cool enjoyment of an umbrageous retreat.

The last seam of coal in the Són, and the highest in the series crops out in several different places near Gúrárú. It Gúrárú seam. is capped by carbonaceous shales and sandstones, and the whole mass of dark-looking rocks forms a conspicuous feature in the river bank. It was the first seam of coal that I met with after we had commenced the survey of the Sohágpúr field. I could obtain no information about coal from the natives ; but by following up the water-borne fragments for several miles along the channel of the Són from the confluence of the Johilla, I discovered the source whence they were derived. The following is the section of the seam :—

| | ft. in. |
|--|------------|
| <i>Coal</i> | <i>5 0</i> |
| Carbonaceous shale | <i>6 0</i> |
| <i>Coal</i> | <i>2 4</i> |
| Carbonaceous shale | <i>2 0</i> |
| <i>Coal</i> | <i>2 8</i> |
| Carbonaceous shale and <i>coal</i> , not all seen. | |

There is a sufficient workable thickness of coal, but an analysis of it by Mr. Mallet was disappointing.

| | | | | | | | | | |
|---------------------------------|---|---|---|---|---|---|---|---|-------|
| Moisture | . | . | . | . | . | . | . | . | 2·7 |
| Volatile, exclusive of moisture | . | . | . | . | . | . | . | . | 9·5 |
| Carbon, fixed | . | . | . | . | . | . | . | . | 40·5 |
| Ash | . | . | . | . | . | . | . | . | 47·3 |
| | | | | | | | | | — |
| | | | | | | | | | 100·0 |

If it were not that the distance between Gúrárú and the Kúnuk outfall was rather too far, and the evidence too imperfect to reduce correlation to a certainty, I might be tempted to suggest that from the similarity in the composition of the coal at these two places, the exposures in both localities are of the same seam.

With this notice is ended the description of all the more important outcrops of coal in the actual bed of the Són and the area drained in the lower courses of the lesser tributaries that join it below Anúkpúr, after the commencement of its traverse through the Barákar group.

A large number of specimens of plants were found with comparatively little trouble in the tracts of land enclosed by the

Fossils.

Són and the supra-Barákars, north of the latitude of Nabálpúr. They were mainly of the genera *Glossopteris*, and *Vertebraria*, and the latter occur in profuse abundance in many spots. Quoting again from Dr. Feistmantel's Fossil-Flora of the Rewah Gondwána basin,¹ the different forms determined, and some of the localities whence a large proportion of them were procured, are—

Amlíha, *Glossopteris communis*, *Glossopteris angustifolia*, *Vertebraria indica*; Maiki, *Glossopteris communis*, *Vertebraria indica*; Murna river, *Trizygia speciosa*, *Dicksonia hughesi*, *Glossopteris angustifolia*, *Gl. communis*; Gúrárú, *Vertebraria indica*, *Schizoneura gondwanensis*, *Glossopteris angustifolia*, *Gl. communis*, *Gl. formosa*, *Gl. formosa* var. *major*, *Gl. indica*, *Gl. browniana*, *Squamæ gymnospermamarum*; Sarsi, *Schizoneura gondwanensis*, *Glossopteris browniana*.

In this list *Vertebraria* is found high up in the series, and it is abundant everywhere. *Trizygia* is seemingly confined to upper beds. Certain

¹ Pal. Ind., Fossil Flora of the Gondwana System, Vol. IV, pt. 1.

species of *Glossopteris* are generally distributed, but others are restricted. *Schizoneura* is more common in upper beds.

There are no specimens of *Gangamopteris*, and it is noticeable that this plant is confined to the lower horizon of the Barákar group.

East of the Són a very convenient division for details of other outcrops may be drawn at the north and south watershed of the Kéwai river and its tributaries, near east longitude 82°. Although the area is a large one, there is a notable absence of thick seams, and indeed there is not one exposure which at first sight would undeniably be declared valuable. Almost without exception every outcrop was imperfect or indistinct. Many of them were entirely under water, and their discovery was chiefly due to having a graduated scale of liberal rewards which excited the exploratory ardour of my camp. There was no opportunity of learning anything by boring, and the fact of coal occurring at Umaria and being worked there made it appear unnecessary to expend time and money in even shallow trenching.

Proceeding eastward from Gúrárú there are carbonaceous shales here and there; and some inferior coal south-east of the Poor coal at Khama. village of Khama. The largest of these outcrops is capped by rather coarse sandstone with a roseate tinge, and the measurements are —

| | | ft. in. |
|------------------------|-------------------|---------|
| Sandstone | · · · · · · · · · | 12 0 |
| Coaly matter and shale | · · · · · · · · · | 5 0 |
| Coal | · · · · · · · · · | 0 8 |

There is nothing inviting in the appearance of this seam, but it is noticeable as being the principal mass of carbonaceous matter for some miles around.

No coal is seen between this and the Obhi river, forming the boundary of the Rewah and Chang Bhakár States, and there are no seams of any importance in the Kúnuk or its feeders until nearing the village of Jaintpúr. Passing over the names of the streams that yield no surface evidence of coal, in order to avoid a deluge of useless references, there

Khappa-Kúta stream. is an outcrop in the Khappar-Kúta within sight of its junction with the Kúnuk, and in descend-

ing order the following rocks are visible :—

| | ft. in. |
|--|---------|
| Fine-grained grey sandstone | 8 0 |
| Blue shales | 2 0 |
| <i>Coal</i> | 1 0 |
| Carbonaceous shales, with a string of coal | 1 0 |
| <i>Coal</i> | 2 0 |
| Shale or coal, under water. | |

In one of the sources of the same stream and about a mile and a quarter south-east of Bándhua hamlet, and the Khohäuser seam, same distance east-north-east of Khohäuser, there is a fair-sized seam with an exposed section of—

| | ft. in. |
|------------------------------|---------|
| <i>Coal</i> | 3 0 |
| Carbonaceous shale | 2 0 |
| <i>Coal</i> | 2 0 |

This is the most promising seam in this part of the field, and though I can assert nothing positively about the goodness of the coal or the real underground relative thickness of the shale, I am inclined to form a favorable judgment of its worth and to hope that the shale may diminish.

In the Kúnuk there is a 4-feet seam of moderate quality below the Kúnuk River: seam outfall of the Dhoran, and then there is a long 4' 0". blank of 8 or 9 miles, in which there is no appearance of true coal. As its head waters are neared, however, there are numerous subsidiary streams, and in them, as also in the Kúnuk, there are some outcrops of carbonaceous matter.

All of them, with the exception of a 3-feet seam of coal south-west of Semaria hamlet, seam 3' 0". of Semaria hamlet, come under the head of 'insignificant,' as neither the quality of their coal nor their thickness at the surface recommends them.

The rivers examined were those flowing past the villages of Kúmerhin, Delbhákherua, and Khamaria, and falling into the Kúnuk on its left bank, and the Bichli and others on the right bank.

At different spots on the 1-inch maps the Topographical Survey have defined as coal what really is carbonaceous shale; but though this mistake has been committed, the records proved very useful in suggesting closer search for

true coal seams, and in directing attention to localities that might otherwise have escaped observation. The bed, however, marked as coal near Kichri does contain 1 foot of coal, the section being, descending

| | ft. in. |
|------------------------------------|---------|
| Carbonaceous shale | 4 6 |
| Sand-stone | 0 6 |
| Argillaceous sandy shale | 1 0 |
| <i>Coal</i> | 1 0 |

There is a small fault running east-north-east.

At several places in the actual channel of the Kúnuk my colleague and myself were fortunate enough to find fossils : *Fossils.* *Schizoneura gondwanensis*, *Glossopteris communis*,

and *Vertebraria indica*.

The Schizoneuræ occurred in grey olive-green shales, bearing resemblance to some of the Panchet and Tálchir shales of the Rániganj field. The Vertebrariæ were found north-north-west of Kanhér, in a bed of carbonaceous and argillaceous shale, and are noticeable because they occur erect. This is the first instance in which I have ever met with roots or stems in such a position, and on account of the rareness of the circumstance, I have thought it worth while recording. There is every appearance of the Vertebrariæ being in their original situation, having grown in the carbonaceous shale, and penetrated into the underlying bed.

Outside the drainage system of the Kúnuk, there is still one river, the Góhirári and its tributaries, lying west of the watershed of the Kéwai, in which there is evidence of coal. It joins the Són within the area of the Tálchirs, but throughout its entire course it is the old story of no seams of a determinable thickness of over 3 feet. There are outcrops near Outcrops. Taraidól, Chinmár, Sardih, Múrdhóa, Ledára, Pakariha, Réula, Bargaon, Dhúma, and Titripónri.

In quality, the seam south of Dhúma and the one north of Réula are seemingly the best, but my opinion must be accepted as open to possible correction when more



J. Schaumburg, Lith.^d

VIEW ON THE KEWAI RIVER, NEAR GAMBHIRUA,
SHOWING EROSION OF BARAKAR SANDSTONE.

Printed at Geol. Survey Office,
Hughes Phot.

detailed and more special enquiry is instituted. I deemed it a sufficient reason, so far as this country is at present concerned, for abridging my examination of a seam when its apparent thickness did not exceed 3 feet; at the same time I am aware that beds of less thickness than this are sometimes successfully worked in Europe.

Kéwai River.—The next observations on coal fall within the drainage system of the Kéwai river, and there is some satisfaction in being able to state that two or three of the outcrops met with rise above the yard limit.

The Kéwai and the Són meet about $2\frac{1}{2}$ miles below the border of the Pendra subdivision of the Biláspur District. Of the two rivers the Kéwai is the larger, and its name should either have been substituted for that of the Són, or the course of the latter should have been along that of its affluent. The scenery of the Kéwai is

Scenery. in many places very bold and impressive, there being repeated stretches of rocky channels and cliffs of coal-measure sandstones. The eroding action of water is remarkably illus-

Gambhirúa : pot-holes. trated in the form of pot-holes; and I have never met with more striking displays in any of the fields that have fallen to my lot to survey, than those which are to be seen in this river. I have selected for this memoir a view near Gambhirúa of an area of erosion just within the boundary of the Barákars, where there are some cave temples, reaches of clear deep water, a succession of small falls, and a lining of forest trees, in fact where circumstances combine to make a varied and an attractive picture.

Proceeding up the Kéwai northwards, two thin bands of coal are exposed between Pasán and Gambhirúa, but the first fair-sized seam occurs Bélha-Paiári : seam 8' 2". west of Bélha Paiári. There are several exposures of it, but the most open one is where there is a warm spring in the left bank of the river, and the section is—

| | ft. in. |
|---------------------------------------|---------|
| <i>Coal</i> | 3 0 |
| Carbonaceous shale | 1 2 |
| <i>Coal</i> , not all shown | 4 0 |

(193)

I have allowed 7 feet of clear coal; and as the analysis of an average sample gave—

| | | | |
|---------------------------------|---|---|--------|
| Water, hygroscopic and combined | . | . | 10.30 |
| Volatile matter | . | . | 25.49 |
| Fixed carbon | . | . | 63.54 |
| Ash | . | . | 10.97 |
| | | | 100.00 |

it will be at once seen from the high amount of fixed carbon in it that this seam may be adjudged a good and useful one.

A little higher up the Kéwai, at the outlet of the Kótma, where there is a waterfall, 1 foot of coal is visible. No Kótma Nadi. other outcrop occurs in this tributary, and for a considerable distance to the north in the main river, and in its successive feeders, there are no signs of coal.

In the Chaurár, however, that joins the Kéwai on its right bank, and on which stands Ningúáni, one of the principal Chaurár Nala. villages of the district, we again meet with a fine seam of coal, as well as others of less value. The lowest in the series is about 2' 0" thick, and lies south of Urtán. Then above it is the largest seam in the section; it is exposed in the southern branch of Chapáui Nala: seam the river, flowing from Chapáni, under an over-6' 7". hanging mass of sandstone. The measurement is 6' 7", but there is more of it under water. The coal seemed to me very good, but, though I broke off a piece for analysis, it does not appear to have reached the laboratory.

Proceeding to the main or northern channel, which is named Singhára, there are two other seams of coal, the Singhára Nala seams. lower of which is not measurable. The upper one is 2' 3", and, unlike most beds of coal, is not accompanied by any under-clay. Above this there is nothing of further interest, but there is a very fine extent of deep clear water, invitingly adapted for a mid-day swim.

Returning to the Kéwai, which is barren of anything in the shape of coal, we next have the Kanai, and its minor Kanai Nala and tributaries. system of tributaries, the Bichli, the Kharbúra, the

Jengúráda, the Sui, the Chilam, and the Gandrá Kúnd and others, of which many rise in the Koréa district. The only seams of proper size crop up near the heads of the Gandrá Kúnd and Chilam streams in localities difficult of access, and which it would probably puzzle me to find a second time. They measure respectively 5' 4" Seams 5' 4" and 5' 0". and 5' 0", and appear to contain good coal. The other seams and bands are either petty in dimensions or poor in character; but for those who in future years may have the curiosity to examine them, I give a list of the village lands within whose limits they lie—

| Village. | Number of seams. | REMARKS. |
|-----------------------|------------------|--|
| Thangaon | One seam . | Coal and shale, 1' 6" seen, rest under water. |
| Bélgaon | One seam . | One foot thick. |
| Bacháoli | One seam . | Seen 2' 6", rest under water |
| Kanai Tolah | One seam . | Section— Coal, 1' 6". Sandy carbonaceous shale, 1' 2". Coal, 1' 6". Sandy carbonaceous shale, 1' 0". Coal, 2". Coal, 1' 0". Seam is repeated several times. |
| Lohári | One seam . | Quite under water. |
| Ratoura | One seam . | Imperfectly exposed, only 2' 0" visible. |

The next tributary of the Kéwai, the Latbúra, was incompletely examined, but I am inclined to think that there Latbúra Nala. are no outcrops of carbonaceous matter, as the portions of its channel that I looked at contained no washings of coal.

North of the Latbúra there is nothing seen for about 5 miles, either Pachkúra seam re-peated. in the Kéwai or other streams, but near Pachkúra is an outcrop of a seam which I believe is repeated in the Kókí, and again at Bichia, Chatai, Haswáhi, Bhalmari, Pippuria, and Kónwáhi. Like the generality of the seams in the neighbour-

hood, it is only partly exposed, and, strange to say, not more than 3 feet are visible in any section. I am quite prepared, however, to express the conviction that it is probably 1 to 2 feet thicker. An analysis of a Kóki Nala coal analysis sample from the Kóki river outerop did not give favorable results, the fixed carbon being meagre, and the ash abundant.

| | | | | | | |
|------------------------------------|---|---|---|---|---|--------|
| Water, hygroscopic and combined | . | . | . | . | . | 212 |
| Volatile matter exclusive of water | . | . | . | . | . | 21.01 |
| Fixed carbon | . | . | . | . | . | 45.50 |
| Ash | . | . | . | . | . | 33.49 |
| | | | | | | <hr/> |
| | | | | | | 100.00 |

At Bichia the union of the Barnai and the Kéwai takes place, and then the latter river forms, for about 7 miles, the boundary between the Koréa and the Rewah States. West of Kérabáhára it is confined to Koréa, and takes it rise between the upland peaks of Khóro and Dhampinga. In this remaining part of the field, watered by the Kéwai and its streams, there are not many seams of noteworthy size, but, as usual, there are several of small dimensions, at Charwáhi, Mouhári, Dúgla, Roji, Kérabáhára, Chaton, Kaparia, and Pakriha. The principal exposure of coal is in a branch of the Jhiria, north of Nerúa. Its thickness is nothing striking, but it looks good, and, as is almost always the case, the dip is easy. The direction locally is to the south. Section—

| | ft. in. |
|-------------------------|---------|
| Coal | 2 0 |
| Carbonaceous shale band | 0 9 |
| Coal | 2 3 |

Hestho River.—The next convenient division of the field is denoted by the important drainage system of the Hestho. And just as the Són is the paramount river in the Rewah State, so is the Hestho in the Koréa State. A few minor tributaries of the Hestho on its right bank just reach into Rewah territory, but with these exceptions the Hestho, at all events in its upper course, is truly a Koréan river. It takes its rise in the heights

north of Súnhat, the capital of Koréa, amongst the supra-Barákar sandstones, and enters the field of the true coal-measures in the vicinity of the town. Its course and that of many of its feeders lies in great part in a hilly and impracticable country so far as communications are concerned. In consequence of this physical drawback connected with the coal-measures, the value of the different bands of coal is so reduced that I have curtailed my notices, and have passed by all but the larger and more important seams with very brief allusions. All the details of locality necessary to again find the outcrops that we met with are in the Chapter of Appendices.

The Barákars are contracted in width in the Koréa State owing to Productive measures in south of field. denudation, and the chief feature in the distribution of the coal is, that the productive measures are confined to the lower horizon of the group, forming a narrow zone along the southern border of the field.

Before describing the Koréan portion proper, there are two streams, Kúlharia and Jhiria the Kúlharia and the Jhiria, tributaries of the Hestho, that rise in the Rewah State and which I should first treat and dispose of. Being tributaries of the Hestho, I left them for notice with the drainage system of that river, but the accident of local position throws the coal-measures that are exposed in them rather out of harmony with the restriction of the fiscal limits of the Koréa State.

There are two seams of coal, of which the upper is exposed close to Bhalmúri, Dúmarka-
chár, seam 5' 4". the village of Bhalmúri, measuring 5 feet 4 inches. The direction of dip just at this locality is to the south, but the rocks undulate, and the seam is again seen near Dúmarkachár. The lower seam is visible at the confluence of the Kúlharia and the Jhiria at the foot of a waterfall. It is capped by greyish-white felspathic sandstone, very soft at the surface with felspar decomposed; there is here and there a slight tendency to ferruginous segregation, but not nearly to such an extent as in the regular MÁhádévas. I make this allusion as a warning, for, though the presence of iron is a very essential

element in characterising the sandstones of the MÁhádÉvás, it often plays a prominent part, but not to so great an extent, in varying the appearance of rocks that do not belong to that group.

| | ft. in. |
|---|---------|
| The thickness of the sandstone is | 28 0 |
| Coal seam | 7 2 |
| | ft. in. |
| <i>Coal</i> | 3 6 |
| Carbonaceous shale | 1 0 |
| <i>Coal</i> | 2 8 |

Underneath this—

| | |
|--|------|
| Carbonaceous shale and sandstone | 2 0 |
| Sandstone | 13 0 |
| <i>Coal</i> and coaly shale | 0 10 |

Then sandstones to the end of the section where the road from Bhauta to Jhagrákhand crosses the stream, and where Tálchirs are brought up by a fault. Owing to the undulations of the strata the seam is repeatedly exposed to view for about a mile and a half in the bed of the stream. The analysis made by Lála Hira Lál, of what was selected as an average sample of the coal, gave—

| | |
|---------------------------|-------------|
| Moisture | 6·7 |
| Volatile matter | 28·2 |
| Fixed carbon | 59·6 |
| Ash | 5·5 |
| | <hr/> 100·0 |

It does not cake. Ash reddish in colour.

This is much more favourable testimony to the excellence of the coal than I anticipated; the smallness of the ash is remarkable, and for the future credit of the Sohágpúr field, I hope this amount of 5·5 per cent. will never be exceeded by this seam. With such fuel as this much might be accomplished, but, unfortunately like most good things, it is not to be easily obtained, being 86 miles further away from a line of rail-

Continuation of seam, way than Umaria. The continuation of this towards the Jhagrákhand seam is met with both to the north in the Jhagrákhand, and to the south in the Néori, 2 miles south-east of Tánki village. My colleague, who traced it in the latter direction, states that 6' 4" are exposed and the rest hidden under water. There is a thin parting of shale, and the quality of the coal is good.

Turning northward, the first tributary of the Hestho that concerns us is the Hasia. It is a rocky stream fed by several branches from the direction of Báhia, Músra, and Báhi. These all unite below the village of Báhi, and thence the Hasia proper begins. Near the boundary of the Barákars with the Tálchirs there is a commanding waterfall known as the Karam Ghág, at the base of which some indifferent coal occurs. Quoting from the manuscript report of Lála Hira Lál, "There are two seams north of the very prominent dyke crossing the Hasia near the waterfall, whose calculated thicknesses are 16 and 22 feet. They dip at high angles." Nothing is said as to their quality, but probably they will be found of the same composition as those that have been analysed and tested.

Besides these, there are eighteen to twenty outcrops, but some of them are repetitions of the same bed, and most of them are under the yard limit. Only two are over it, bearing roughly east of Báhi, and measuring 5' 0" and 3' 10" respectively. In the Karakachár Nala.

Karakachár, which is the stream adjoining the Hasia, there are only two full-sized seams amongst the many outcrops which are visible. The lowest in the series measures 4' 8". A sample of it was analysed, but the amount of ash was very high.

| | | | | | | | | | |
|-------------------------------------|---|---|---|---|---|---|---|---|-------|
| Moisture | . | . | . | . | . | . | . | . | 2·26 |
| Volatile matter, exclusive of water | . | . | . | . | . | . | . | . | 9·62 |
| Carbon, fixed | . | . | . | . | . | . | . | . | 48·40 |
| Ash | . | . | . | . | . | . | . | . | 39·72 |
| <hr/> | | | | | | | | | |
| 100·00 | | | | | | | | | |

The other seam is 7' 6". Both dip at rather high angles, 18° to 20°.

The outcrop of a large seam, which I take to be the extension eastward of one of those already noted, occurs in one of the streams north of the village of Balbahára.

Balbahára seam. It is clearly exposed in a precipice, and possesses a total thickness of 10 feet of coal. The section according to Lála Hira Lál is, descending

| | ft. | in. |
|---------------|---------|------|
| Sandstones | . | . |
| Coal inferior | . | 2 0 |
| Shales, about | . | 8 0 |
| Coal | . | 10 0 |
| | (199) | |

Analyses of three specimens from different parts of the 10' 0" seam, gave moderately promising results, showing, in fact, that, as compared with the average of Rániganj field coals, it could quite hold its own—

EXCLUSIVE OF WATER.

| Volatile matter | Fixed carbon. | Ash. |
|-----------------|---------------|-------|
| 30·42 | 57·51 | 12·07 |
| 28·85 | 53·42 | 17·73 |
| 27·84 | 51·32 | 20·84 |

There are two other, but smaller seams.

Next comes the Dhúnéti, into which several little streams fall, Dhúnéti Nadi. but I met with only three unimportant outcrops between Ghútra and Báhia. There are some fine waterfalls in its course, and the tongue of land enclosed by it and the Hestho near their junction, is one of the favorite "drives" of the Raja of Koréa, Parán Sing, who is an enthusiastic sportsman.

After the Dhúnéti comes the Hestho itself. Its scenery is repeatedly diversified by some imposing waterfalls, amongst Hestho River. which is the one at Kirwáhi forming the frontispiece. This is unquestionably the most striking and charming of all the falls in this amply watered country. There is a broad sweep of rock over which the greater portion of the stream precipitates itself in one Waterfall. sheer drop, and then flows on through a long winding gorge below, blocked with enormous masses of debris, from amongst which and on which a rich vegetation springs. It was a refreshing sight in the warm days of the summer months, and I felt that I had parted with one of the sweets of life when my duty obliged me to leave it behind.

Strange to say, there are no seams of noteworthy size or quality, except one, in the whole length of the Hestho from where it enters the area of the Barákars near Súnhat to the point whence it leaves them Seam 5' 0". at Lai. It occurs at the end of the gorge below the waterfall, and has the following section :—

| | | | | | | | | | | | | ft. in. |
|--------|---|---|---|---|---|---|---|---|---|---|--|---------|
| Coal . | : | : | : | : | : | : | : | : | : | : | | 1 11 |
| Shale | : | : | : | : | : | : | : | : | : | : | | 0 6 |
| Coal . | : | : | : | : | : | : | : | : | : | : | | 5 0 |

In the face of the waterfall there are four carbonaceous bands, but it is only the third in descending order that has true coal in it. Its thickness is 3' 6."

Near the villages of Balsing and Basér there are indications of coal, but from those localities eastward to within a mile of the Jhilmili border, there is, practically speaking, no coal with the exception of the belt of productive measures to the south. Signs of carbonaceous deposits are not altogether wanting, but they either rank clearly below the dignity of coal, or they are too thin, or too indistinctly exposed to be classed definitely as worth consideration.

Outercrops, various. In this category are included the outcrops near Kúsaha, Amhár, Súnhat, Orgai, Tunjára, Pathargua, Bhoswai, and Latma.

Of the productive band to the south, the remarks which have already been made of the area west of the Hestho give the reading. There are, amongst many smaller seams, two of sufficient size to be workable under the present ordinary conditions of Indian mining. To obtain a standard section my colleague and myself ascended most of the streams, large and little, which, curiously enough, have their watershed nearly coincident with the upper limit of the productive measures, but there was in each instance too much incompleteness in the sequence of the rocks to secure this result. We saw, however, outcrops after outcrops, which of course were only the repeated symptoms of the same seams. The rivers we examined specially were those of the villages of Lai, Harra, Kachár, Nagar, Labji, Sardih, and Chúrcha.

Beyond Chúrcha is the border land of Jhilmili, the boundary between which and Koréa passes by Roudserai and Tanjara. To the north-

Roudserai seam. north-west of Roudserai, which is situated on the new district road joining the capitals of the two States, a good seam of coal occurs, but I could not see its entire thickness.

The small area of Barákars extending into Jhilmili was examined Barákars in Jhilmili State. and mapped by Lála Hira Lál. A considerable portion of it is overlaid by trap, coursing north-east

and south-west and separating the field into two narrow strips. Coal occurs at several localities, but its value is reduced, as in Koréa, by the impracticable nature of the country.

In the northern strip of the field, the main stream is the Góknai, Northern area of field. and in it and in nearly all its feeders there are out-crops of coal and carbonaceous shale. The principal ones are exposed near the deserted village of Jumri.

Southern area of field. In the southern strip, the coal is gathered within the circle of Kundour and Kupi villages.

There is a stray outcrop near Déókhola, and another in the Géj Déókhola and Rukaia outcrops. west of Rukaia. At this latter place the coal seems of tolerable quality, and the seam, which occurs at the base of a waterfall, is not less than 6 feet. Angle of dip 10°. Direction N. N. W.

This concludes the references to the distribution of the coal-measures in this extensive field. The number of distinct seams is small, and for such an area there is not an abundance of coal. The lateral extension, Estimate of quantity however, is so great that the problem of how many not made. million tons of coal are there, and for how many years at a given rate of consumption will the coal last, may be left for solution to the coming geologists of the twentieth century.

SECTION XI.—THE KÚRÁSIA COAL-FIELD.

This title, derived from the name of the only inhabited village within the limit of the coal measures that it applies to, defines an independent tract of Barákars lying south of the main area, and east of the Hestho river in the Koréa State.

The superficial area is 48 square miles, and it embraces some very Area. wild country densely packed with bamboo jungle, to which ferine elephants are wont to resort both for food and shelter.

Owing to the difficulty of obtaining supplies for our camp, my colleague and myself had to be content with making a couple of arduous

traverses from north to south, and along the course of the Kaoria stream.

Survey of field incom. The survey of the field therefore has not been a
plete. complete one, but the boundaries are sufficiently
defined to allow of their being published until such time as more finished
details are required.

These traverses proved the existence of coal, and the occurrence of the ordinary rocks that accompany it elsewhere. On one of the higher hills south of Kúrásia, there is a capping of supra-Barákar sandstone; and possibly on the Bartunga and Anjan hills there may be similar deposits. They were not visited, however, and I make the suggestion merely on account of the heights marked on the map.

Seven outcrops of coal were met with, of which the three most important are in the vicinity of the village of Kúrásia. The Outcrops of coal. finest seam, with a total measurement of 13' 6," was discovered by Lála Hira Lál at the head of one of the feeders of the Seam 13' 6". Kúdra, and the result of the analysis of a sample of average coal gave—

| | | | | | | | |
|---------------------------------|---|---|---|---|---|---|--------|
| Water, hygroscopic and combined | . | . | . | . | . | . | 2.20 |
| Volatile matter | . | . | . | . | . | . | 29.15 |
| Fixed carbon | . | . | . | . | . | . | 64.65 |
| Ash | . | . | . | . | . | . | 6.20 |
| | | | | | | | 100.00 |

Such figures as these are a high recommendation, and should this coal at any future time fall within reasonable distance of any demand, it ought not to be overlooked.

The second seam, measuring 6' 6", occurs a mile and a half S. S. E. of Kúráisia, and, like the one first alluded to, contains excellent coal. The sample examined had the following composition:—

(203)

The third seam crops out in the Gorghéta, a tributary of the Hestho, about half way between Kúrásia and the site of the deserted village of Dúbchóla. It is 8' 0" thick, and the coal is fairly good.

The remaining seams are inferior to these, and their positions only have been noted.

SECTION XII.—THE KORÉAGARH COAL-FIELD.

This independent area of Barákars is a small basin, of which merely the outline has been traced. It lies south-east of the Kúrásia field, and covers about 6 square miles. The name given to it was suggested by my colleague, from the hill of Koréagarh, which is the highest point in it.

With respect to coal, only a hurried examination was made. No seams of any value were noticed; but this does not in the least imply that they do not occur; and it is highly probable that with closer search they will be proved. In his manuscript report Lála Hira Lál says:

Koréagarh hill. "Went to see the hill named Koréagarh, in order to make out to what formation the rocks belong.

As one ascends, the first rocks met with are grey felspathic sandstones, then yellowish-grey felspathic sandstones, then ferruginous sandstones of Máhádéva type. Descending the hill, the following section occurs in a stream :—

He further alludes to a thin band of coal, 6 inches thick, near Dúgidai hill. There is no other information to quote, and the apology for the scantiness of the details in connection with this field is, that two days only were assigned to its survey.

SECTION XIII.—THE JHILMILI COAL-FIELD.

Under the above name, Mr. V. Ball, formerly of our Survey, designated a semi-detached portion of the main area lying principally within the limit of the Jhilmili State; and as I am almost entirely indebted to the notes that he has left behind him for the matter here published, I have retained both the title and the limits that he selected.¹

So far as is at present known, the coal-measures occupy a lenticular-shaped area of about 41 square miles, with its long axis running S. W.—N. E. They are stated to be faulted on the north, and thus brought into contact with an alternate succession of Tálchir and metamorphic rocks. To the south they are for the most part but little disturbed.

The evidence of the main fault is very clear in a small stream near the village of Tarka, the Barákar sandstones having been lowered along a line of fracture to the level of the more ancient rocks. In the Mánikmára stream, the faulted character of the northern boundary is still more clearly exposed. Mr. Ball states: "North of the line of fracture, there are Tálchir shales and flags which are horizontal or slightly rolling towards the north. At the fracture the edges of these beds are crushed and dragged down, and the Barákar sandstones close by are tilted to angles of from 40° to 50° to S. and S. E., their edges being in direct apposition to those of the Tálchirs. Associated with these sandstones, there are two small and much-crushed seams of coal, measuring respectively 1' and 2' 0". A more beautiful and clearly-exposed example of the mechanical effects resulting from a fault is not often met with."

Of seams of coal, there are none exposed in the River Rér, on the left bank of which the town of Jhilmili is built, and there are no outcrops in the Pasla stream. In the Mánikmára, however, in addition to the two crushed seams

¹ The eastern extremity of this field is shown in Mr. Ball's map of the Bisrámpur coal-field, Records, Vol. VI., part 2, 1873.

near the fault, Mr. Ball found others, one of which was of excellent quality. He describes the river section as follows: "A couple of reaches above the northern boundary there is a step of sandstone, over which the water falls from a height of about 30 feet into a deep hollow. Passing this, another coal seam is reached, on the western bank of

Coal seam, 3' 6" exposed. the river; it exhibits an extraordinary amount of local disturbance, dipping at angles of 45°—50° N.

This high inclination is, however, soon lost, and not far off, on the eastern bank, it is nearly horizontal like the accompanying sandstones. The base of the seam is hidden. In the exposed portion there is about 3' 6" of poor stony coal.

"A short distance further up stream, just inside the mouth of a small tributary, there is a seam of excellent coal, the top of which only is

Coal seam good. Only 1' 4" exposed, measuring 1' 4". The analysis made of this coal by Mr. Tween freely justifies the good opinion formed of it in the field:—

| Analysis— | | | | | | | | | |
|-----------------|---|---|---|---|---|---|---|---|-------|
| Volatile matter | . | . | . | . | . | . | . | . | 33.8 |
| Fixed carbon | . | . | . | . | . | . | . | . | 60.6 |
| Ash | . | . | . | . | . | . | . | . | 5.6 |
| | | | | | | | | | 100.0 |

It is, moreover, a good caking coal. Its practical usefulness as a source of fuel depends upon the total thickness of the seam. The amount and direction of the dip is uncertain; but the former is inconsiderable.

"Following the river up to the entrance of the valley north of the Kaltanghát hill, the rise is so steep and constant that progression entails a great amount of physical exertion. The stream falls over a succession of steps formed of massive beds of sandstone, and three coal seams are seen, bearing N. and N. E. from

Three seams.

Kaltanghát peak—

| | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|-------|
| 1. Coal, good | . | . | . | . | . | . | . | . | 1' 2" |
| 2. Coal seam with stony parting, base hidden | . | . | . | . | . | . | . | . | 6' 6" |
| 3. Coal seam, inferior to No. 2 | . | . | . | . | . | . | . | . | 6' 0" |

All these seams are nearly horizontal, and accordingly so far favourable for working. Their position in the valley is, however, eminently not so.

"To the westward, in one of the tributaries of the Dharsinda, two coal seams are imperfectly exposed. They are Dharsinda Nala. probably identical with two of the seams described above, as occurring in the Mánikmára section."

There are no other remarks about coal exposures, but Mr. Ball mentions that fragments of coal are abundant in the Góbri Nadi. bed of the Góbri near Nouapára, and far southward in the Tálchir area.

The notice of the coal-measures of this field is confessedly imperfect, and Mr. Ball has been careful to say in his report that his examination was very hurriedly carried through, with a view merely to obtaining a rough idea of the rocks to guide future more detailed work.

SECTION XIV.—SUPRA-BARÁKARS.

Above the undoubted coal-measures are a succession of rocks extending up to known Jabalpúr beds, but whose relationships are as yet too uncertain for me to say with confidence to what group or groups they should be assigned; in order to defer the solution of their classification to a more convenient season, they are provisionally termed supra-Barákars.¹

Their most prominent feature is the occurrence of ferruginous and silicio-ferruginous matter, producing different degrees of induration and various ferric tints. There are all gradations of texture, but coarse-grained sandstones predominate. Pebble beds and likewise conglomerates occur. Shales—red, pink, lavender, and mottled (red, purple, and yellow)—are moderately frequent in the lower portion of the group, and, being usually brightly coloured, readily catch the eye. Clays occur occasionally.

As seen in the Jóhilla valley, where the best section in the whole of the South Rewah area is to be met with, the sandstones are massively bedded, often false-bedded, generally coarse-grained, and friable when not indurated by iron; rusty

¹ On the map one colour represents the entire series of rocks between the coal-measures and the Laméta group.

brown, salmon, and various shades of grey and yellow are the most common colours; scattered pebbles and strings of pebbles are frequent; ferruginous matter, either in bands, in strings, or in plates, or as a general indurating agent, is freely distributed; mica is not nearly so universal a mineral component as it is in the Barákar group.

A very marked feature in many of the sandstones is their weathered Weathered surface. appearance, when owing to unequal degradation their surfaces are traversed by chisel-edged ribs running usually in various directions, but occasionally presenting the symmetry of geometrical figures.

In some respects, that is, in reference to their petrological and lithological features, they might at once be placed partly with the Panchét group, and partly with the Mähadéva group as understood in the Bengal Conflict of palaeontolo-
gical evidence. coal-fields; but the palaeontological evidence is conflicting, for such fossils as have been found in them indicate a somewhat lower horizon than that of the Mähadéva. Perhaps the Kámthi group, as defined in the Wardha valley coal-field, would more fittingly embrace the various characters that appertain to these supra-Barákar beds, there being in that area a like assortment of clays, varied sandstones, pebble beds, and abundant ferruginous matter. From my published notes in the Records of the Survey it may be gathered how strongly I was of opinion that in the valley of the Jóhilla the strata immediately above the unquestionable coal-measures were Mähadévás. On re-consideration, however, I think the suggestion of Dr. Feistmantel in the *Palaeontologia Indica* embodies a more reasonable view of the situation, and that some portion of the area mapped as supra-Barákars should form an intermediate zone between the Mähadévás and the coal-measures.

Taking the section of the Jóhilla river in ascending geological order Fossils. from the Barákar boundary, there is a small island at the mouth of the Bichna Nala, and in some purplish fine-grained argillaceous sandstone that forms a thin bed amongst more massive sandstones that I had judged to be Mähadévás, I found *Vertebraria indica*, *Glossopteris communis*, and *Glossopteris indica*. On the left bank of the Bichna there are strong pebble beds and ferrugi-

nous sandstones, which strengthened my belief that I was dealing with a group high in the Góndwána series ; and it was, I confess, disconcerting when the palaeontological evidence was so much at variance with my first conclusions. On the same line of strike are the rocks of Dhaurai, Uchéhra, Karkati, Kúrábar, and the Múrcha Pass lying, broadly speaking, to the north of the village of Páli composed of coarse pebbly sandstones, yellowish, grey, massively bedded, and frequently with oblique lamination. At intervals, purplish fine-grained argillaceous sandstones and brick-red clays, and fine-grained purple sandstones frequently so ferruginous as to become iron ore¹ beds. All these appeared to me to assimilate in character with the Máládéva group, but here also the palaeontological facts were, that at Karkati, in very ferruginous red-brown slightly sandy shale, there were specimens of *Equisetaceous* stems, *Schizoneura* ? *Sphenopteris polymorpha*, *Glossopteris communis*, *Glossopteris cordata*, and seeds. From Kúrábar, *Vertebraria indica*, *Schizoneura*, *Sphenopteris polymorpha*, *Glossopteris communis*, *Glossopteris damudica* ; and from the Múrcha Pass in very ferruginous micaceous sandy shale, near Ganjra, *Glossopteris communis*.

From Parsóra, which is still farther to the north, in extremely fine-

grained dark-red ferruginous shales, associated with
 Fossils at Parsóra. sandstones having altogether Máládéva features,
Daneopsis hughesi, *Thinnfeldia* (comp.) *odontopteroides*, *Asplenium whitbyense*, and *Nöggerathiopsis hislopi*, were identified by Dr. Feistmantel, and classed by him as Lower rather than Upper Góndwána forms. Here we have fossils distinctly newer than those of the Jóhilla and in the vicinity of Páli, but they are associated with rocks whose features are quite identical with those of the latter localities, and we shall have to determine at some future time what value this circumstance bears.

On the outskirt of the Umaria field at Chatán, *Vertebraria indica* and *Glossopteris angustifolia* were obtained in buff shale intermixed with

¹ Two analyses of ferruginous argillaceous sandstones from the Jóhilla river showed—

| | No. 1. | No. 2. |
|-------------------------------------|--------|--------|
| Ferric oxide | 41.14 | 36.00 |
| Loss on ignition | 6.05 | 8.00 |
| Ignited insoluble residue | 52.80 | 52.80 |
| Undetermined | 3.21 | 3.20 |

white sandstones. The rocks here will probably be assigned to either the Panchéts or Kámthis, as there are red lumpy shales, and white and pink argillaceous sandstones, such as are frequently met with in the latter group.

Over the remaining area embraced by the map in the eastern part of the Rewah State, and in the Cháng Bhakár and Koréa States, I certainly think the supra-Barákars are Máládévás. It remains to be seen whether palaeontological evidence confirms this opinion, or whether the value of our Góndwána fossil forms will have to be freshly appraised.

SECTION XV.—LAMÉTA.

Of this group I have only to mention that it is utterly unconformable to all the series of rocks included under the heading of supra-Barákars, and that the distinctive rock in it is limestone. Sandstones and clays occur; the former usually fine-grained, soft in texture, and often greenish-grey and purple tinted; the latter are of various colours, but more frequently deep iron-red and greenish.

The Laméta group is otherwise known as the Infra-trappeans, being very extensively found underlying the Deccan trap, and closely related to it and to the like deposits occurring between the trap flows, known as Inter-trappeans. Both are fresh-water deposits, of upper cretaceous or lowest eocene age. They have thus been compared to the similarly placed Laramie group of North America (Records, G. S. I., xvii, p. 87).

SECTION XVI.—TRAP.

A large part of the trap that has been mapped in South Rewah is clearly a continuation of the great Deccan (Dakhan) trap formation, and it is found capping an extensive elevated area in the drainage basin of the Jóhilla, and various portions of the Sóhágpúr and Koréa districts to the eastward.

Within the coal-field there are well-defined sheets and dykes, and the question which arises is, whether these are of different age to the covering trap-flows. I can adduce no evidence that they are distinct, and I have coloured them as belonging to the same formation.

There are some instances of partial horizontal intrusion, and one clear case is seen in the left bank of the Jóhilla river about a mile north of Chichára. At Harha on the Són there is another example, and here the upper sandstone with which it is in contact is hardened, thus showing that it is not a contemporaneous lava flow.

As a rule very little contact action appears to have taken place along lines of intrusion: two instances may be mentioned, one between Mahrói and Kánnábáhára west of the town of Sóhágpúr, and another near the junction of the Rájghata and the Kúnuk, in which the varying steps of alteration effected by trap are most clearly exhibited.

The first one was pointed out by Lála Hira Lál, where sandstone has been changed not only into quartzite, but also into a highly crystalline rock resembling gneiss and granite. The belt of metamorphic action is about 30 yards wide, and the trap is seen intruded in greater or less quantities.

In the Rájghata noticed by myself, I was at first of opinion that I had met with an inlier of metamorphic rocks, but on closer investigation it was apparent that the case was similar to that near Kánnábáhára, and I was able to select specimens illustrating the various stages of alteration from sedimentary sandstone to a rock which was quite undistinguishable in the hand from ordinary granite.

These instances of metamorphism are interesting owing to their rarity, as in no other coal-field have I observed the same phenomena.

CHAPTER III.

ECONOMIC.

SECTION XVII.—COAL.

I have previously drawn attention to the fact of there being in the Appendix a list of all the places at which outcrops of coal have been found in the various fields described in this memoir. I propose reducing

my remarks under the present section of Economic Geology to the facts in connection with the coal of the Umaria field, its greater geographical importance, and the more complete determination of its value as compared with those of the other coal-measure areas, having made it the real gauge of their present worth.

As at present proved in No. 7a bore-hole, there is a maximum thickness of coal in the surface. This is accumulated in two seams measuring respectively 13 and 11 feet, and separated by 25 feet of carbonaceous sandstone. The outcrop of the lower of these is visible in the Umrár river near Kálésar. It is traceable thence westward through ravines and gullies south of and near to No. 1 shaft. From that point, there is no sign of coal in the direction of the Narsara Nala or elsewhere, and it becomes a matter of supposition as to how the outcrop runs. Probably the strike changes, and veering to the north-west and north gradually becomes parallel with the Chatán range of hills. Speaking generally, the dip of the measures within the exposed limits of the field

is to the north-east at a low angle; but from the Local variations of dip. evidence in No. 2 shaft there is the probability of local variations, for the level course at that spot in the field is north-east and south-west. Such variations, however, are always to be expected, and do not affect the main dispositions for the working of a colliery.

There is no evidence of the second seam at the surface, but I think that the journals show it to be nearly co-extensive with the lower seam. Many of the borings were not carried through the whole thickness of the coal bands, but such as were, bear testimony to two seams,—as, for example, those where the shafts are placed, and Nos. 7a and 16.

In speaking of the thickness of the coal, then, we may reasonably assume that after excluding a superficial breadth of 500 feet from the outcrop of the lower seam, measured in the direction of the general dip, there is quite 20 feet of it.

The full area over which this thickness occurs is undetermined ; but Calculable area 4 square miles down to 500 feet if the limit of a reasonable working depth of 500 feet is taken, we may say that there are 4 square miles in and around the neighbourhood of the village of Umaria.

These data give us a total quantity of 80 million tons of coal, of which 55 millions may be taken as available within Available quantity. an area of 4 square miles at a depth of 500 feet from the surface. I merely give this estimate to satisfy the desire for figures which seems inseparable from the mention of a coal-field. The statement that there are 55 millions of tons of coal within a given area expresses the value of a restricted portion of the coal-measures.

There is every likelihood that coal occurs under the supra-Barákars in the direction of Gangri, Maihmár, Kúa, and Piparia, and that it extends continuously to the exposed edges of the Kórár field. Such a contingency as this, of course, raises the total quantity of coal, and the union of the Umaria and Kórár fields through Chirwár, Múrgúri, and Barbspúr, and so on, increases the number of tons to a formidable amount.

Abundant opportunity has been afforded for judging both of the Nature of seam and quality of coal. nature of the seams and the quality of the different bands of coal that they contain. In reference to the outcrop explorations, Mr. Forster says that the coal works easily, and that the thin band of soft shale under the bottom of the seam will facilitate pricking, and so reduce very materially the amount of waste. The roof is an excellent one, and, except quite near the entrance to the different inclines, not a single stick of timber has been required to support it. This is a most favourable feature in the estimation of a seam, for when the roof is bad the expenditure under the heading of timber forms a considerable item ; and there is the constant dread of accidents to life.

In No. 2 shaft the coal can easily be got in large blocks, and up to the present time the roof has shown no signs of weakness.

The composition of the coal has been determined by several assays made by M. M. Mallet and Fedden and Lála Híra Lál in the labora-

tory of the Survey. A complete series of samples was taken from where the seam crops in the quarry, and the following figures show the relative percentages of volatile matter, fixed carbon, and ash in the several bands into which the seam was divisible:—

| | EXCLUSIVE OF MOISTURE. | | | Moisture. |
|-----------------|------------------------|---------------|------|-----------|
| | Volatile matter. | Fixed carbon. | Ash. | |
| A | 25·1 | 55·6 | 19·3 | 5·8 |
| C | 31·1 | 55·6 | 13·3 | 3·6 |
| D | 20·1 | 58·7 | 21·2 | 2·6 |
| E | 35·6 | 56·9 | 7·5 | 3·4 |
| F | 25· | 36·4 | 38·6 | 2·2 |
| H | 26·4 | 60·9 | 12·7 | 2·4 |
| „ | 26·7 | 59·2 | 14·1 | 2·4 |
| „ | 30·0 | 53·6 | 16·4 | 2·6 |
| „ | 28·4 | 60·7 | 10·9 | 2·8 |

The bright soft coals C and E are excellent in quality, and I am strongly of opinion that they would yield a fair

Gas coal. amount of gas for illuminating purposes. The

Bands C and E. best coal supplied from the Rániganj field for the use of the Oriental Gas Company of Calcutta yields between 9,000 and 10,000 cubic feet of gas to the ton, and judging from the appearance of the bands C and E, they seem quite capable of giving the same quantity.

Clinker band D. The band indicated as D would have to be picked out, as it clinkers readily.

The band F is scarcely within the limit of coal, and it was analysed in view of its capability as an oil-producing material. It yielded about 15 per cent. of oils and

tarry matter.

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The main stay of the seam is the bottom portion, and there is no bottom portion of disputing its worth. Bearing in mind that the seam good steam coal. Specimens examined were from the outerop, we have in the analyses before us the worst aspect that the coal presents, and as this is better than that of the average of the fuels from the Ráni-ganj field, we have at the outset a high standard of excellency.

The coal has a dull look like that of the best Karharbári coal, and is very compact.

It appears to be homogeneous, but when separated into its layers, finely divided mother-of-coal is visible on most of the faces. This is a favourable feature and usually means that the coal will have considerable heating power. It ought to be a good steam coal, and it bears transport well.

A strong point in its favour is the manner in which it withstands **Coal withstands** weathering. A stack was left exposed to the full force of the sun and rain for nine months, and at the end of that time the coal showed no sign of deterioration. Usually the laminated coals of Bengal and the Wardha valley split into thin papery layers when left unprotected, and occasionally they take fire, but in both these respects the Umariá coal has proved very satisfactory.

No attempt has yet been made to produce coke in ovens, but my **Coal probably caking** belief is, that it may be converted into just as good if properly treated. coke as is now produced in the Karharbári field, the soft bands containing sufficient bituminous matter to act as a binding medium.

In the analyses, no determination of sulphur was made, but this **Sulphur.** purity disfigures the coal in places, and though **Caution concerning fire.** there is not enough to cause anxiety in stacked coal, care should be exercised to keep the workings perfectly clear of dust, otherwise the misfortune that overtook the Warora colliery will probably be repeated at Umariá, and loss both of life and money may be the result.

The running power of the coal has been tested on several occasions
 Running power of coal on the East Indian and Great Indian Peninsula
 Railways, and with one of the trial trips on the latter line I was personally concerned. Reports were drawn up by the Locomotive Superintendent of the Great Indian Peninsula Railway and by Mr. Thomas Forster, the Manager and Mining Engineer of the Umaria Colliery, and I give extracts from them further on.

The coal was from the outcrop galleries, and no other care was taken than to pick out the clinker band. There was no selection, and the average of one consignment will be the average of another until the character of the seam itself varies. After the necessary arrangements, the local foreman of the line, Mr. Forster and myself left Jabalpúr on the 12th May 1884, with a baggage train of an average gross weight, excluding the engine and tender, of 410 tons, and our run was to Sohág-púr, a distance of 122 miles. Mr. Forster, in addressing the Political Agent of Rewah, stated :—

Mr. Forster's report. "I have the honour to submit a report of the trial trip made on the night of the 12th instant.

"By the kindness of the Traffic Superintendent, Mr. Maurice, we were given a full train-load of 32 vehicles, the biggest load run on the portion of the line between Jabalpúr and Gadawára. The locomotive supplied by Mr. Watson of the Locomotive Department was all that could be desired for trial of coal.

"We started from Jabalpúr at 10-20 p.m., arriving at Sohág-púr about 9 a.m. on the morning of the 13th.

"I am exceedingly glad to say that the coal steams admirably. Even when going up hill with the full load, steam was blowing off from the safety valve. The fire was cleaned out twice on the journey, not that it was really necessary, but it is better always to trim the fire in a journey so as to prevent the fire-box getting chocked and so prevent the admission of air.

"On arrival at Sohág-púr we found that the Traffic Superintendent had telegraphed permission to weigh the train.

“ The gross average weight amounted to 410 tons.

“ At starting we had 3 tons 16 cwts. and 19 lbs. of coal on the tender, lighting up of engine included. The amount of coal left on tender after completing the trip was 1 ton 9 cwts. 2 qrs. 2 lbs. The consumption on the journey was therefore 2 tons 6 cwts. 1 qr. 21 lbs.

“ The evaporation was 5·4 lbs. to 1 lb. of coal.”

“ Reducing these figures to the standard of pounds consumed per train mile, we have 8,531 lbs. — 3,330 lbs. = 5,201 lbs., the actual amount burnt. Then $\frac{5,201 \text{ lbs.}}{122 \text{ miles.}} = 42\cdot63 \text{ lbs.}$ per train mile.

“ This compares favourably with Karharbári coal, as a 500-ton train on the East Indian Railway is run at the rate of 48 lbs. per train mile. Then 500 tons : 48 lbs. :: 410 tons = 39·36 lbs. per train mile for same weight of train.

“ The average consumption per mile of the Mohpáni coal is 55 lbs., so that we ran 12·37 lbs. per mile less.

“ I think this speaks well for the quality of the Umaria coal, and places beyond doubt the assertion that it is an excellent country fuel. During the trip I noted particularly that very few sparks were thrown out, and that the coal is not more fuliginous than the general run of country coal.”

I am of opinion that Mr. Forster has given more credit to the Mohpáni coal than it is entitled to, for, in the last annual report of the Director of Railways, the all-round figures per train mile are 100. Allowing, however, 55 lbs., the comparison for different coals is—

| Karharbári. | Umara. | Rániganj. | Mohpáni. |
|-------------|------------|-----------|-----------------|
| 39·36 lbs. | 42·63 lbs. | 51·00 | lbs. 55·00 lbs. |

The report of the Locomotive Superintendent, Great Indian Peninsula Railway, was addressed to the Agent of the Superintendent. Company, and he summarised the various trials that had been made. His conclusions were, “ The coal is of very good quality, and does very well, much better than either the Warora or the Narbadda¹ coals, and not very much inferior (if at all) to that received

¹ This is Mohpáni coal. The name of the colliery is Mohpáni.

from Giridih collieries in Bengal. The coal steams well, has very little clinker, but a large amount of ash; it throws very few sparks, and makes little smoke. It should not be forgotten that the above report is based upon a small consignment which we have received from the colliery and was no doubt specially selected. I am, however, of opinion that if coal such as has been sent to us can be guaranteed, we could have nothing to complain of."

In these extracts we have the opinions of practical authorities, and although there is no gainsaying an assay, it is pleasant, when advocating the claim of any given object, to find engineers and chemists in accord with each other. And I think it reasonable to conclude that even in the outcrop coal at present being worked in the Umaria field, we have a high-class fuel.

In No. 2 shaft much better coal has been reached, the amount of excellent coal in No. 2 fixed carbon that it contains showing a marked shaft. advance on that of the very best of the samples from the outcrop workings. I again give the analysis:—

| EXCLUSIVE OF WATER. | | | |
|-----------------------|------------------|---------------|------|
| | Volatile matter. | Fixed carbon. | Ash. |
| No. 2 shaft | 25·17 | 66·71 | 8·12 |

None of this coal has been tried for locomotive purposes, but it should equal anything turned out either by the Karharbári or Rániganj fields.

In view of attempts to utilise the magnificent resources of the Jabalpur district for the production of iron, the small manufacture of iron. amount of ash is a most promising feature, for one of the greatest drawbacks in connection with the endeavours to make pig-iron in the Wardha valley at Warora was the large quantity of impurity in the form of ash that the fuel contained. It was quite 50 to 60 per cent. in excess of that in the Umaria pit coal.

After exactly three years of preliminary explorations,¹ the Umaria field has passed from the control of the Rewah Administration to that of the Government of India, who have decided to work it during the minority of the Mâhârâjâh and to pay a handsome royalty of eight annas a ton on the raisings.

With unquestioned credit, and absolved from the necessity of large profits, the Government of India can increase its area of distribution to a much greater extent than the policy of any private company would permit, and therefore with larger proportionate raisings, the arrangement that has been entered into is the very best possible for the Rewah State. A fixed annual rental could never have been calculated at the true rate of production, whereas a royalty binds in equal degree the interests of the colliery and the lord of the soil.

Under the title of the Umaria Coal Estate, I have indicated the limits of the area over which it would be well to acquire boundaries. surface and mineral rights, so that future mining operations may be carried on without the recurring necessity of taking up fresh land and re-opening negotiations regarding its value.

The boundaries agreed upon have the advantage of being distinct and simple; they are, the range of Chatán hills to the west, the Umrâr river to the north and east, and the line of railway to the south, and include a superficies of about 4 square miles.

SECTION XVIII.—IRON ORE.

I have no information to proffer regarding iron ores, but in so far as the possibility of using Umaria coal to utilise the magnificent deposits of iron in the Jabalpûr district brings the coal-field into relation with them, I would mention, for the information of those who may be interested in bringing smelting operations to a practical issue, that in the Records of the Survey, Vol. XVI, Part 2, Mr. F. R. Mallet has given all the most important facts known regarding the iron ores, and subsidiary materials for the manufacture of iron in the north-eastern part of

¹ The first boring was commenced 22nd January 1882, and the coal-field, comprised within the boundary of the Umaria Coal Estate, was transferred 21st January 1885.

the Jabalpúr district. In the early part of 1881 Mr. Trimmell was successful in treating the iron ores in the neighbourhood of Múrwára, but the fuel employed was charcoal. No attempt has been made to use Umaria coal, but I have lately been informed that the Government (Central Provinces) intend making a few trials with some best selected pit coal as fuel. Instead of carrying out independent experiments, however, I think the better plan would be to forward ore and fuel to the Barákar iron-works where the whole process of manufacture has been brought under practical control.

SECTION XIX.—LIMESTONE.

Limestone is found abundantly in the form of rock limestone, wherever the Laméta group is developed.

The Bijáwar formation also yields it; and within the Lora metamorphic inlier there are beds of crystalline limestone.

The Laméta limestone varies a great deal, and care must be exercised in its selection if it be intended for use.

Kankar is freely distributed, but its occurrence in large nodules is restricted to small areas. Tufa or travertine is also met with.

The following analyses show the average composition of the different lime-bearing sources:—

| VILLAGE. | POSITION OF VILLAGE. | | Insolubles. | Oxide of iron and alumina. | Carbonate of lime. | Carbonate of magnesia. ¹ | REMARKS. |
|-----------------------|----------------------|--------------|-------------|----------------------------|--------------------|-------------------------------------|--|
| | Latitude N. | Longitude E. | | | | | |
| Kálésar (Rewah) . . | 23° 31 | 80° 54 | 20°10 | 4°95 | 71°40 | 3 55 | Kankar burnt for lime at Umaria. |
| Karimati , , . | 23° 29 | 80° 53 | 1°65 | 1°05 | 95°20 | 2°10 | Tufa. |
| Mahádéopárá (Korea) . | 23° 12 | 82° 38 | 0°15 | °50 | 99°3 | °05 | " |
| Bódri (Rewah) . . | 23° 11 | 81° 30 | 5°9 | °60 | 86°5 | 5°6 | Lameta limestone. { Sand 3°8 } = Insoluble Clay 2°1 5°9. |
| Jhápi , , . | 23° 27 | 80° 37 | 14°90 | °75 | 51°60 | 32°75 | Bijáwar limestone. |
| Majgama , , . | 23° 33 | 80° 50 | 7°95 | °90 | 73°40 | 17°75 | Metamorphi limestone. |

¹ In these analyses, magnesia was determined by difference.

SECTION XX.—CLAY.

There appears to be a great want of good clay for even ordinary bricks in the Umaria coal-field, and in default of better material the arenaceous alluvial clay along the banks of the Umrár river has to be used. A very limited amount of clay is procurable in the tanks around Umaria, but it will not hold out for long. Perhaps the scarcity of a suitable substance for brick-making may force the use of stone, which in my opinion would be an advantage, as ensuring more permanency in the buildings that may have to be erected. The village potters of Umaria and Kálésar, after specially treating the sandy clays, make excellent porous drinking-vessels.

SECTION XXI.—BUILDING STONES.

Considering the large area of sandstones over which choice may be made, it would not at first sight seem a difficult task to procure building stone suitable for most purposes. From the statements, however, of the various engineers who have been engaged upon the survey of the Bilás-púr-Etawah Railway, it appears that the scarcity of good stone is a very serious embarrassment in their plans for heavy bridging.

The sandstones of the coal-measures are all soft when really quarried, but they possess the advantage of hardening by exposure to the air. Closed-grained sandstones occur in plenty throughout the Upper Barákar series, and I am of opinion that it merely requires search to obtain stone of suitable strength. Probably the question of the lead (distance) has more to do with the perplexity of supply than anything else.

Beyond the Umaria field, excellent material is procurable between Kirintál and Amha, and the rollers and grindstones in use at the Umaria colliery are obtained from the quarries in the neighbourhood of those villages. For less exact requirements than those of bridges and engine foundations, the coal-measure standstones would fully answer.

CHAPTER IV.

APPENDICES.

SECTION XXII.--BORING SECTIONS.

Umaria--Rewah State.

No. 1.

Commenced 22nd January 1882.

Ended 15th February 1882.

Water tapped at 37 feet from surface.

Coal struck at 49 feet from surface.

| | | ft. | in. |
|------------------------------------|-------------------|-------------|----------|
| 1. Black surface soil | . | 1 | 6 |
| | brown | | |
| | grey | | |
| | red | | |
| | yellow | 42 | 6 |
| | mottled | | |
| | shaly | | |
| 2. Sands and sandstone | | | |
| 3. Sandstone, carbonaceous, shaly | | 3 | 0 |
| 4. Shale, carbonaceous | | 2 | 0 |
| 5. Coal | | 3 | 0 |
| 6. Shale, carbonaceous | | 1 | 0 |
| 7. Sandstone, grey, shaly | | 1 | 0 |
| 8. Coal | | 7 | 0 |
| 9. Sandstone, carbonaceous, shaly | | 9 | 0 |
| 10. Shale, carbonaceous | | 2 | 0 |
| 11. Coal | | 2 | 0 |
| 12. Sandstone, carbonaceous, shaly | | 3 | 0 |
| 13. Sandstone, white | | 16 | 0 |
| | | <hr/> TOTAL | <hr/> 93 |
| | | 0 | |

T. G. STEWART,
In charge of Boring Operations,
Rewah Coal Explorations.

Umaria—Rewah State.

No. 2.

| | |
|---|--|
| Commenced | 26th January 1882. |
| Ended | 11th February 1882. |
| Coal struck at 64 feet from surface. | |
| | ft. in. |
| 1. Surface soil | 3 0 |
| 2. Sandstone . . . | { brown yellow grey } 24 0 |
| 3. Clay, carbonaceous | 1 0 |
| 4. Sandstone . . . | { brown shaly } 5 0 |
| 5. Clay, carbonaceous | 2 0 |
| 6. Sandstone . . . | { brown yellow grey red shaly } 29 0 |
| 7. Coal | 11 0 |
| 8. Shale, carbonaceous | 4 0 |
| 9. Sandstone, carbonaceous, shaly | 3 0 |
| 10. Sandstone, grey | 16 0 |
| | TOTAL . . 98 0 |

T. G. STEWART,

In charge of Boring Operations,
Rewah Coal Explorations.

Umaria—Rewah State.

No. 3.

| | |
|--------------------------------------|---|
| Commenced | 6th February 1882. |
| Ended | 24th " " |
| Coal struck at 75 feet from surface. | |
| | ft. in. |
| 1. Black surface soil | 4 0 |
| 2. Sandstones and clays . . | { white brown yellow grey } 64 0 |
| | Carried over . . 68 0 |
| | (223) |

T. G. STEWART,
In charge of Boring Operations,
Rewah Coal Explorations.

Umaria—Rewah State.

No. 4

Commenced 11th February 1882.

Coal struck at 79 feet from surface.

| | | Brought forward | ft. | in. |
|-----|--|-----------------|-----|-----|
| 3. | Shale, carbonaceous | | 44 | 0 |
| 4. | Sandstone, brown, shaly | | 2 | 0 |
| 5. | Shale, carbonaceous | | 1 | 0 |
| 6. | Sandstone, carbonaceous, shaly | | 4 | 0 |
| 7. | „ grey, shaly | | 2 | 0 |
| 8. | „ brown | | 7 | 0 |
| 9. | „ carbonaceous | | 1 | 0 |
| 10. | Clay „ | | 1 | 0 |
| 11. | Sandstone, „ shaly | | 2 | 0 |
| 12. | „ grey „ | | 4 | 0 |
| 13. | „ carbonaceous „ | | 1 | 0 |
| 14. | „ grey and brown | | 8 | 0 |
| 15. | „ carbonaceous, shaly | | 1 | 0 |
| 16. | <i>Coal</i> | | 6 | 0 |
| 17. | Sandstone, carbonaceous, shaly | | 1 | 0 |
| 18. | <i>Coal</i> | | 2 | 0 |
| 19. | Shale, carbonaceous | | 2 | 0 |
| 20. | <i>Coal</i> | | 3 | 0 |
| 21. | Shale, carbonaceous | | 2 | 0 |
| | | TOTAL | 95 | 0 |

T. G. STEWART,
In charge of Boring Operations,
Rewah Coal Explorations.

Umaria—Rewah State.

No. 8.

Commenced 21st April 1882.

Ended 10th May 1882.

Coal struck at 84 feet from surface.

| | | | ft. | in. |
|----|------------------------|---|-----|-----|
| 1. | Surface soil | | 4 | 0 |
| | Clay | | 4 | 0 |
| 2. | Sandstone | { brown grey red white } | 76 | 0 |
| | | | | |
| | Carried over | | 84 | 0 |
| | (225) | | | |

| | | | | | | | | | | | ft. | in. |
|-----------------------------------|---|-------|---|---|---|---|---|---|---|---|-------|-----|
| | | | | | | | | | | | 84 | 0 |
| 3. <i>Coal</i> | . | . | . | . | . | . | . | . | . | . | 1 | 0 |
| 4. Sandstone, carbonaceous, shaly | . | . | . | . | . | . | . | . | . | . | 3 | 0 |
| 5. Shale | . | . | . | . | . | . | . | . | . | . | 5 | 0 |
| 6. <i>Coal</i> | . | . | . | . | . | . | . | . | . | . | 10 | 0 |
| 7. Shale, carbonaceous | . | . | . | . | . | . | . | . | . | . | 3 | 0 |
| 8. Sandstone | " | shaly | . | . | . | . | . | . | . | . | 5 | 0 |
| 9. <i>Coal</i> | . | . | . | . | . | . | . | . | . | . | 7 | 0 |
| 10. Shale, carbonaceous | . | . | . | . | . | . | . | . | . | . | 4 | 0 |
| 11. Sandstone | . | . | . | . | . | . | . | . | . | . | 14 | 0 |
| 12. " carbonaceous, shaly | . | . | . | . | . | . | . | . | . | . | 4 | 0 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | TOTAL | . |
| | | | | | | | | | | | 140 | 0 |

T. G. STEWART,
In charge of Boring Operations,
Rewah Coal Explorations.

Umaria—Rewah State.

No. 9.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---------------|---|---|--------------|---|
| Commenced | . | . | . | . | . | . | . | 1st May 1882. | | | | |
| Ended | . | . | . | . | . | . | . | 10th | , | " | | |
| <i>Coal</i> struck at 63 feet from surface. | | | | | | | | | | | | |
| 1. Black and brown soil | . | . | . | . | . | . | . | . | . | . | 8 | 0 |
| 2. Sandstone, brown | . | . | . | . | . | . | . | . | . | . | 9 | 0 |
| 3. " red | . | . | . | . | . | . | . | . | . | . | 30 | 0 |
| 4. " carbonaceous, shaly | . | . | . | . | . | . | . | . | . | . | 3 | 0 |
| 5. " | . | . | . | . | . | . | . | . | . | . | 13 | 0 |
| 6. <i>Coal</i> | . | . | . | . | . | . | . | . | . | . | 2 | 0 |
| 7. Shale, carbonaceous | . | . | . | . | . | . | . | . | . | . | 1 | 0 |
| 8. Sandstone, " shaly | . | . | . | . | . | . | . | . | . | . | 3 | 0 |
| 9. <i>Coal</i> | . | . | . | . | . | . | . | . | . | . | 10 | 0 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | Carried over | . |
| | | | | | | | | | | | 79 | 0 |

| | | | | | | | | ft. | in. |
|-----|--------------------------------|---|---|---|---|---|-----------------|------|-----|
| | | | | | | | Brought forward | . 79 | 0 |
| 10. | Sandstone, carbonaceous, shaly | . | . | . | . | . | . | . 3 | 0 |
| 11. | Shale, carbonaceous | . | . | . | . | . | . | . 1 | 0 |
| 12. | <i>Coal</i> | . | . | . | . | . | . | . 2 | 0 |
| 13. | Shale, carbonaceous | . | . | . | . | . | . | . 1 | 0 |
| 14. | <i>Coal</i> | . | . | . | . | . | . | . 6 | 0 |
| | | | | | | | TOTAL | . 92 | 0 |

T. G. STEWART,
In charge of Boring Operations,
Rewah Coal Explorations.

Umaria—Rewah State.

No. 9A.

Commenced 8th November 1883
 Ended 28th " "

Water tapped at 11 feet from surface.

Coal struck at 57 feet from surface.

| | | | | | | | | ft. | in. |
|-----|------------------------|---|---|---|---|---|---|-----|-----|
| 1. | Brown surface soil | . | . | . | . | . | . | . 3 | 6 |
| 2. | Sandy clay | . | . | . | . | . | . | . 3 | 0 |
| 3. | Sand | . | . | . | . | . | . | . 6 | 0 |
| 4. | White sandstone | . | . | . | . | . | . | . 2 | 0 |
| 5. | Red | " | . | . | . | . | . | . 1 | 0 |
| 6. | Yellow | " | . | . | . | . | . | . 1 | 0 |
| 7. | Reddish-grey sandstone | . | . | . | . | . | . | . 1 | 0 |
| 8. | Grey | " | . | . | . | . | . | . 1 | 0 |
| 9. | Yellow | " | . | . | . | . | . | . 1 | 0 |
| 10. | Red | " | . | . | . | . | . | . 1 | 0 |
| 11. | Grey | " | . | . | . | . | . | . 3 | 0 |
| 12. | Reddish grey | " | . | . | . | . | . | . 5 | 0 |
| 13. | Grey | " | . | . | . | . | . | . 2 | 0 |
| 14. | Reddish grey | " | . | . | . | . | . | . 2 | 0 |
| 15. | Grey | " | . | . | . | . | . | . 1 | 0 |
| 16. | Reddish grey | " | . | . | . | . | . | . 1 | 0 |
| 17. | Grey | " | . | . | . | . | . | . 1 | 0 |

Carried over . . 35 6

(227)

| | | Brought forward | ft. | in. |
|-----|------------------------------|-----------------|-----|-----|
| 18. | Yellowish sandstone | . | 1 | 0 |
| 19. | Grey | " | 1 | 0 |
| 20. | Reddish grey | " | 2 | 0 |
| 21. | Grey | " | 1 | 0 |
| 22. | Reddish grey | " | 1 | 0 |
| 23. | Grey | " | 3 | 0 |
| 24. | Reddish grey | " | 3 | 0 |
| 25. | Red | " | 1 | 0 |
| 26. | Grey | " | 9 | 0 |
| 27. | <i>Coal</i> | . | 2 | 0 |
| 28. | Carbonaceous shale | . | 3 | 0 |
| 29. | Carbonaceous shaly sandstone | . | 3 | 0 |
| 30. | " shale | . | 1 | 0 |
| 31. | <i>Coal</i> | . | 8 | 0 |
| 32. | Carbonaceous shale | . | 1 | 0 |
| 33. | <i>Coal</i> | . | 1 | 0 |
| 34. | Carbonaceous shale | . | 1 | 0 |
| 35. | <i>Coal</i> | . | 1 | 0 |
| 36. | Carbonaceous shale | . | 3 | 0 |
| 37. | <i>Coal</i> | . | 4 | 0 |
| 38. | Carbonaceous shaly sandstone | . | 2 | 0 |
| 39. | Grey sandstone | . | 9 | 0 |
| | | TOTAL | 96 | 6 |

A. MUNSCH,
Assistant Mining Engineer,
Rewah Coal Explorations.

Umaria—Rewah State.

No. 10.

Commenced 10th May 1882.

Ended 18th " "

Coal struck at 36 feet from surface.

| | | ft. | in. |
|----|--------------------------------|-------|------|
| 1. | Brown surface soil | 9 | 0 |
| 2. | Sandstone . . { Grey | 27 | 0 |
| | { Brown | | |
| 3. | <i>Coal</i> (not gone through) | 3 | 0 |
| | | TOTAL | 39 0 |

T. G. STEWART,
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Rewah Coal Explorations.

Umaria—Rewah State.

No. 11.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|----------------|-----|----|---|
| Commenced | . | . | . | . | . | . | . | . | . | . | . | 17th May 1882. | | | |
| Ended | . | . | . | . | . | . | . | . | . | . | . | 21st | " | | |
| <i>Coal</i> struck at 45 feet from surface. | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ft. | in. | | |
| 1. Surface soil | . | | | | | | | | | | | 5 | 0 | | |
| | | | | | | | | | | | | { black | | | |
| | | | | | | | | | | | | brown | | | |
| 2. Sandstone | . | | | | | | | | | | | 34 | 0 | | |
| | | | | | | | | | | | | { light brown | | | |
| | | | | | | | | | | | | brown | | | |
| 3. Sandstone, carbonaceous | . | . | . | . | . | . | . | . | . | . | . | 3 | 0 | | |
| 4. Shale | . | . | . | . | . | . | . | . | . | . | . | 2 | 0 | | |
| 5. <i>Coal</i> , shaly | . | . | . | . | . | . | . | . | . | . | . | 1 | 0 | | |
| 6. <i>Coal</i> | . | . | . | . | . | . | . | . | . | . | . | 6 | 0 | | |
| 7. Shale, carbonaceous | . | . | . | . | . | . | . | . | . | . | . | 5 | 0 | | |
| 8. <i>Coal</i> | . | . | . | . | . | . | . | . | . | . | . | 3 | 0 | | |
| 9. Shale, carbonaceous | . | . | . | . | . | . | . | . | . | . | . | 1 | 0 | | |
| 10. Sandstone, , | . | . | . | . | . | . | . | . | . | . | . | 5 | 0 | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | TOTAL | . | 65 | 0 |

T. G. STEWART,

*In charge of Boring Operations,**Rewah Coal Explorations.*

Umaria—Rewah State.

No. 12.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|----------------|-----|----|---|
| Commenced | . | . | . | . | . | . | . | . | . | . | . | 22nd May 1882. | | | |
| Ended | . | . | . | . | . | . | . | . | . | . | . | 27th | " | | |
| <i>Coal</i> struck at 31 feet from surface. | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ft. | in. | | |
| 1. Surface soil, brown sandy | . | . | . | . | . | . | . | . | . | . | . | 15 | 0 | | |
| | | | | | | | | | | | | { light brown | | | |
| 2. Sandstone | . | . | . | | | | | | | | | white | | | |
| | | | | | | | | | | | | brown | | | |
| 3. Sandstone, carbonaceous, shaly | . | . | . | . | . | . | . | . | . | . | . | 2 | 0 | | |
| 4. <i>Coal</i> | . | . | . | . | . | . | . | . | . | . | . | 1 | 0 | | |
| | | | | | | | | | | | | Carried over | . | 32 | 0 |
| | | | | | | | | | | | | (| 229 |) | |

| | | | | | | | | ft. in. |
|----------------------------|---|---|--------|---|---|---|-----------------|---------|
| | | | | | | | Brought forward | . 32 0 |
| 5. Sandstone, carbonaceous | . | . | . | . | . | . | . | . 6 0 |
| 6. Sandstone | . | . | yellow | . | . | . | . | . 23 0 |
| | | | grey | . | . | . | . | |
| | | | brown | . | . | . | . | |
| 7. Shale, carbonaceous | . | . | . | . | . | . | . | . 3 0 |
| 8. Coal (not gone through) | . | . | . | . | . | . | . | . 8 0 |
| | | | | | | | TOTAL | . 72 0 |

T. G. STEWART,
*In charge of Boring Operations,
 Rewah Coal Explorations.*

Umaria—Rewah State.

No. 13.

Commenced 1st April 1883.

Ended 14th " "

Coal struck at 96 feet from surface.

| | | | | | | | | ft. in |
|-------------------------|---|---|---|---|---|---|-------|---------|
| 1. Surface soil, brown | . | . | . | . | . | . | . | . 2 0 |
| 2. Clay, stone and sand | . | . | . | . | . | . | . | . 12 0 |
| 3. Sandstone, grey | . | . | . | . | . | . | . | . 13 0 |
| 4. Coal, mud | . | . | . | . | . | . | . | . 2 6 |
| 5. Shale, blue | . | . | . | . | . | . | . | . 8 0 |
| 6. Sandstone, grey | . | . | . | . | . | . | . | . 50 0 |
| 7. Shale, blue | . | . | . | . | . | . | . | . 8 6 |
| 8. Coal | . | . | . | . | . | . | . | . 7 0 |
| | | | | | | | TOTAL | . 103 0 |

T. FORSTER,
*Mining Engineer,
 Rewah Coal Explorations.*

Umaria—Rewah State.

No. 16.

| | | | | | | | | |
|---|---|---|---|---|---|---------------------|---|-------|
| Commenced | . | . | . | . | . | 16th December 1883. | | |
| Ended | . | . | . | . | . | 22nd | " | " |
| Water tapped at 18 feet from surface. | | | | | | | | |
| <i>Coal</i> struck at 88 feet from surface. | | | | | | | | |
| 1. Surface soil, black | . | . | . | . | . | . | . | 8 2 |
| 2. Clay, sandy | . | . | . | . | . | . | . | 3 2 |
| 3. Sand, yellow | . | . | . | . | . | . | . | 7 11 |
| 4. Sandstone | . | . | <div style="display: inline-block; vertical-align: middle; text-align: center;"> brown grey red yellow reddish grey </div> | . | . | . | . | 55 0 |
| 5. Shale, carbonaceous, with pyrites | . | . | | . | . | . | . | 6 0 |
| 6. Sandstone, grey | . | . | | . | . | . | . | 1 0 |
| 7. " carbonaceous | . | . | | . | . | . | . | 2 0 |
| 8. " shaly | . | . | . | . | . | . | . | 4 0 |
| 9. Coal, with shale | . | . | . | . | . | . | . | 1 0 |
| 10. <i>Coal</i> | . | . | . | . | . | . | . | 1 0 |
| 11. Coal, with shale | . | . | . | . | . | . | . | 1 0 |
| 12. <i>Coal</i> | . | . | . | . | . | . | . | 1 0 |
| 13. Sandstone, carbonaceous, soft | . | . | . | . | . | . | . | 2 0 |
| 14. <i>Coal</i> | . | . | . | . | . | . | . | 7 0 |
| 15. Shale, carbonaceous | . | . | . | . | . | . | . | 7 0 |
| | | | | | | TOTAL | . | 107 3 |

A. MUNSCH,
Assistant Mining Engineer,
Rewah Coal Explorations.

Kâlésar—Rewah State.

No. 5.

| | | | | | | | | |
|--------------------------------------|---|---|---|---|---------------------|--------------|------|------|
| Commenced | . | . | . | . | 25th February 1882. | | | |
| Ended | . | . | . | . | 6th March 1882. | | | |
| Coal struck at 47 feet from surface. | | | | | | | | |
| | | | | | | | | |
| 1. Brown soil | . | . | . | . | . | . | 9 0 | |
| 2. Sandstone, red | . | . | . | . | . | . | 38 0 | |
| | | | | | | Carried over | . | 47 0 |
| | | | | | | (| 231 |) |

| | | ft. in. |
|----------------------------|-----------------|--------------|
| | Brought forward | . 47 0 |
| 3. Coal | | . 10 0 |
| 4. Sandstone, white, shaly | | . 2 0 |
| | TOTAL | . 59 0 |

T. G. STEWART,
In charge of Boring Operations,
Rewah Coal Explorations.

Kálésar—Rewah State.

No. 6 B.

Commenced 2nd April 1882.

Ended 27th May 1882.

Water tapped at 23 feet from surface.

Coal struck at 120 feet from surface.

| | | ft. in. |
|------------------------------------|---------------------------|--------------|
| 1. Surface soil | | . 8 0 |
| 2. Sand and clay, brown | | . 15 0 |
| 3. Sandy clay, with pebbles, brown | | . 2 0 |
| 4. Sandstone | | . 95 0 |
| | { red | |
| | { white shaly | |
| | { mottled shaly | |
| | { grey | |
| 5. Coal | | . 1 0 |
| 6. Sandstone, carbonaceous | | . 1 0 |
| 7. Coal | | . 2 0 |
| 8. Sandstone, carbonaceous | | . 2 0 |
| 9. Coal | | . 2 0 |
| 10. Sandstone, carbonaceous | | . 8 0 |
| 11. " grey | | . 6 0 |
| 12. " carbonaceous | | . 19 0 |
| | TOTAL | . 161 0 |

T. G. STEWART,
In charge of Boring Operations,
Rewah Coal Explorations.

THE SOUTHERN COAL-FIELDS OF THE REWAH GONDWANA BASIN

G. MARIA KOBARI, JOMELLA SUDAGPIL, KERASIA

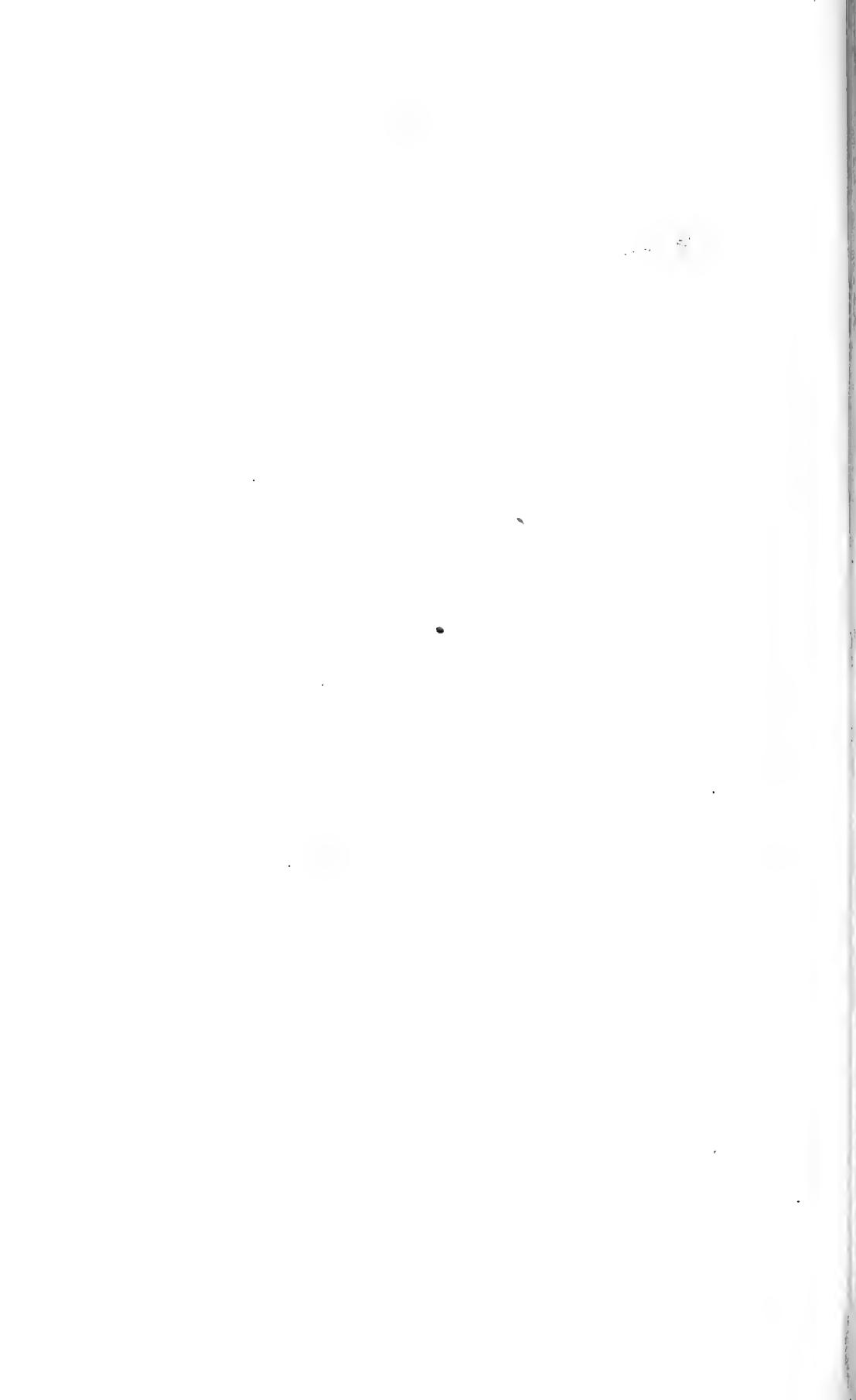
KODAKAGARI JEWELRY

On Faculty Served by Two W. H. Hubs and Sub-Areas of Hexagonal

$\rho_{ab} + \rho_{ba} = 1.078$

Mile 9





Kálésar—Rewah State.

No. 7 A.

Commenced 17th March 1882.
Ended 30th April 1882.
Coal struck at 135¹/₄ feet from surface.

| | | | | | | | | | ft. | in. |
|-----------------------------------|---------|--------|---|---|---|---|---|-------|-----|-----|
| 1. Dark-brown surface soil | . | . | . | . | . | . | . | . | 16 | 0 |
| | brown | . | . | . | . | . | . | . | | |
| | mottled | . | . | . | . | . | . | . | | |
| | red | . | . | . | . | . | . | . | | |
| 2. Sand and sandstone | . | yellow | . | . | . | . | . | . | 78 | 0 |
| | white | . | . | . | . | . | . | . | | |
| | grey | . | . | . | . | . | . | . | | |
| | shaly | . | . | . | . | . | . | . | | |
| 3. Sandstone, carbonaceous, shaly | . | . | . | . | . | . | . | . | 5 | 0 |
| 4. , , grey | . | . | . | . | . | . | . | . | 1 | 0 |
| 5. , , carbonaceous | . | . | . | . | . | . | . | . | 5 | 0 |
| 6. Sandstone, grey | . | . | . | . | . | . | . | . | 2 | 0 |
| 7. , , carbonaceous | . | . | . | . | . | . | . | . | 8 | 0 |
| 8. , , grey | . | . | . | . | . | . | . | . | 20 | 0 |
| 9. Coal | . | . | . | . | . | . | . | . | 13 | 0 |
| 10. Sandstone, carbonaceous | . | . | . | . | . | . | . | . | 25 | 0 |
| 11. Coal | . | . | . | . | . | . | . | . | 11 | 0 |
| | | | | | | | | TOTAL | 184 | 0 |

T. G. STEWART,
In charge of Boring Operations,
Rewah Coal Explorations.

Johilla Valley.—Rewah State.

No. 2.

Coal struck at 34 feet from surface.

| | | | | | | | | | | | | ft. | in. | |
|---------------------------|---|---|---|---|---|---|---|---|---|---|---|--------------|-----|---|
| 1. Clay, yellow | . | . | . | . | . | . | . | . | . | . | . | 1 | 0 | |
| 2. Sandstone, brown shaly | . | . | . | . | . | . | . | . | . | . | . | 15 | 0 | |
| 3. Clay, carbonaceous | . | . | . | . | . | . | . | . | . | . | . | 2 | 0 | |
| | | | | | | | | | | | | Carried over | . | |
| | | | | | | | | | | | | 18 | 0 | |
| G | | | | | | | | | | | | (| 233 |) |

| | | | | | | | | | | ft. | in. |
|-----|--------------------------------|---|---|---|---|---|---|---|-----------------|-----|------|
| | | | | | | | | | Brought forward | . | 18 0 |
| 4. | Shale, carbonaceous | . | . | . | . | . | . | . | . | . | 9 0 |
| 5. | Sandstone, grey shaly | . | . | . | . | . | . | . | . | 2 | 0 |
| 6. | „ brown „ | . | . | . | . | . | . | . | . | 5 | 0 |
| 7. | <i>Coal</i> | . | . | . | . | . | . | . | . | 17 | 0 |
| 8. | Sandstone, carbonaceous, shaly | . | . | . | . | . | . | . | . | 1 | 0 |
| 9. | „ grey shaly | . | . | . | . | . | . | . | . | 1 | 0 |
| 10. | <i>Coal</i> | . | . | . | . | . | . | . | . | 3 | 0 |
| 11. | Sandstone, carbonaceous, shaly | . | . | . | . | . | . | . | . | 1 | 0 |
| 12. | „ grey shaly | . | . | . | . | . | . | . | . | 1 | 0 |
| 13. | „ carbonaceous, shaly | . | . | . | . | . | . | . | . | 3 | 0 |
| 14. | <i>Coal</i> | . | . | . | . | . | . | . | . | 8 | 0 |
| 15. | Sandstone, carbonaceous, shaly | . | . | . | . | . | . | . | . | 4 | 0 |
| 16. | „ grey shaly | . | . | . | . | . | . | . | . | 2 | 0 |
| 17. | Shale, carbonaceous | . | . | . | . | . | . | . | . | 2 | 0 |
| 18. | Sandstone, grey shaly | . | . | . | . | . | . | . | . | 1 | 0 |
| 19. | „ carbonaceous, shaly | . | . | . | . | . | . | . | . | 1 | 0 |
| 20. | „ grey shaly | . | . | . | . | . | . | . | . | 4 | 0 |
| 21. | „ carbonaceous | . | . | . | . | . | . | . | . | 1 | 0 |
| 22. | „ grey | . | . | . | . | . | . | . | . | 6 | 0 |
| | | | | | | | | | TOTAL | . | 90 0 |

T. G. STEWART,
*In charge of Boring Operations,
 Rewah Coal Explorations.*

Jóhilla Valley—Rewah State.

No. 3.

Commenced 13th March 1882.

Ended April 1882.

Coal struck at 6 feet from surface.

| | | | | | | | | | | ft. | in. |
|----|-----------------------|---|---|---|---|---------|---|---|--------------|-----|------|
| 1. | Surface soil, brown | . | . | . | . | . | . | . | . | 1 | 0 |
| 2. | Sandstone | . | . | . | . | „ brown | . | . | . | 5 | 0 |
| | | | | | | „ grey | . | . | . | | |
| 3. | <i>Coal</i> | . | . | . | . | . | . | . | . | 17 | 0 |
| 4. | Sandstone, grey shaly | . | . | . | . | . | . | . | . | 1 | 0 |
| 5. | Shale, carbonaceous | . | . | . | . | . | . | . | . | 6 | 0 |
| | | | | | | | | | Carried over | . | 30 0 |

| | | | | | | | | | | ft. | in. |
|-----|--------------------------------|---|---|---|---|---|---|---|-----------------|-----|------|
| | | | | | | | | | Brought forward | . | 30 0 |
| 6. | Sandstone, grey shaly | . | . | . | . | . | . | . | . | 1 | 0 |
| 7. | Shale, carbonaceous | . | . | . | . | . | . | . | . | 1 | 0 |
| 8. | Sandstone, „ shaly | . | . | . | . | . | . | . | . | 8 | 0 |
| 9. | Shale, „ | . | . | . | . | . | . | . | . | 2 | 0 |
| 10. | <i>Coal</i> | . | . | . | . | . | . | . | . | 6 | 0 |
| 11. | Sandstone, carbonaceous, shaly | . | . | . | . | . | . | . | . | 6 | 0 |
| 12. | „ grey | „ | . | . | . | . | . | . | . | 4 | 0 |
| | | | | | | | | | TOTAL | . | 58 0 |

T. G. STEWART,
In charge of Boring Operations,
Rewah Coal Explorations.

Kórár.—Rewah State.

No. 1.

Commenced 19th February 1884.

Ended 16th March 1884.

Water tapped at 7 feet from surface.

Coal struck at 12 feet from surface.

| | | | | | | | | | | ft. | in. |
|-----|--|---|---|---|---|---|---|---|--------------|-----|-------|
| 1. | Sandstone, reddish yellow | . | . | . | . | . | . | . | . | 6 | 0 |
| 2. | Sand, yellow, with gravel | . | . | . | . | . | . | . | . | 3 | 0 |
| 3. | Sandstone, brown | . | . | . | . | . | . | . | . | 3 | 0 |
| 4. | <i>Coal</i> | . | . | . | . | . | . | . | . | 8 | 0 |
| 5. | Shale, carbonaceous, with coal | . | . | . | . | . | . | . | . | 3 | 0 |
| 6. | <i>Coal</i> | . | . | . | . | . | . | . | . | 4 | 0 |
| 7. | Shale, carbonaceous, with coal | . | . | . | . | . | . | . | . | 2 | 0 |
| 8. | <i>Coal</i> | . | . | . | . | . | . | . | . | 4 | 0 |
| 9. | Shale, carbonaceous | . | . | . | . | . | . | . | . | 8 | 0 |
| 10. | Sandstone, grey | . | . | . | . | . | . | . | . | 62 | 0 |
| 11. | Shale, carbonaceous, with coal and pyrites | . | . | . | . | . | . | . | . | 8 | 0 |
| 12. | Sandstone, grey | . | . | . | . | . | . | . | . | 11 | 0 |
| | | | | | | | | | TOTAL | . | 122 0 |

A. MUNSCH,
Assistant Mining Engineer,
Rewah Coal Explorations.

(235)

Kórár—Rewah State.

No. 3.

Commenced 13th March 1884.

Endedj 20th March 1884.

Water tapped at 12 feet from surface.

Coal struck at 48 feet from surface.

| | | ft. in. |
|-----------------------------------|--------------|-------------|
| 1. Brown surface soil | | 3 0 |
| 2. Sandstone, grey | | 42 0 |
| 3. Sandstone, carbonaceous, shaly | | 3 0 |
| 4. Coal, shaly | | 7 0 |
| 5. Shale, carbonaceous | | 6 0 |
| 6. Sandstone, grey | | 2 0 |
| | TOTAL | 63 0 |

A. MUNSCH,
Assistant Mining Engineer,
Rewah Coal Explorations.

SECTION XXIII.—INDEX OF COAL SITES.

| Village. | River. | State. | Lat. N. | Long. E. |
|--------------------------------------|----------------------------------|------------|---------|----------|
| Achala, $\frac{1}{2}$ a mile E.N.E. | Umrár | Rewah . | 23° 36' | 80° 51' |
| Agariápára, 1 mile W.N.W. | A tributary of the Góknai | Jhilmili . | 23° 28' | 82° 46' |
| ," 1 mile N.W. | Ditto ditto. | | | |
| Amhár, 1 mile E.N.E. | Ghúngatta, a tributary of Hesto. | Koréa . | 23° 29' | 82° 31' |
| Báhi, $\frac{3}{4}$ of a mile N.N.E. | A tributary of Hesia . | ," . | 23° 21' | 82° 15' |
| ," 1 mile S.S.W. | Ditto ditto. | | | |
| ," 1 mile S.E. | Ditto ditto. | | | |
| ," 2 miles S.S.E. | Hesia. | | | |
| ," 2½ miles South | Ditto. | | | |
| ," 2½ miles South | Ditto. | | | |
| ," 3½ miles South | Ditto. | | | |

| Village. | River. | State. | Lat. N. | Long. E. |
|--|----------------------------------|--------|---------|----------|
| Bahgár, $\frac{1}{2}$ a mile E. | Kasér | Rewah | 23° 21' | 81° 43' |
| „ $\frac{1}{2}$ a mile N.E. | Ditto. | | | |
| „ $\frac{3}{4}$ of a mile N.E. | Ditto. | | | |
| Bakábi, $\frac{1}{2}$ a mile N. | Són | „ | 23° 13' | 81° 39' |
| Balbahára, 1 mile N.N.E. | A tributary of Hesto | Koréa | 23° 18' | 82° 19' |
| „ $1\frac{1}{4}$ miles N. | A tributary of Karaka-chár. | | | |
| „ $1\frac{1}{2}$ miles N. | Eastern tributary of Karakachár. | | | |
| „ 1 mile N. N. W. | Ditto ditto. | | | |
| „ 1 mile W.S.W. | Ditto ditto. | | | |
| „ $1\frac{1}{2}$ miles W.N.W. | Western tributary of Karakachár. | | | |
| „ $1\frac{1}{2}$ miles W.N.W. | Ditto ditto. | | | |
| „ 2 miles W.N.W. | Ditto ditto. | | | |
| „ 2 miles W.N.W. | Ditto ditto. | | | |
| „ $2\frac{1}{4}$ miles N.W. | Ditto ditto. | | | |
| „ $2\frac{1}{2}$ miles N.W. | Ditto ditto. | | | |
| „ $2\frac{3}{4}$ miles W.N.W. | Ditto ditto. | | | |
| Balsing, $\frac{1}{4}$ of a mile N.N.W. | A tributary of Hesto | Koréa | 23° 23' | 82° 21' |
| „ $\frac{1}{4}$ of a mile S.S.E. | Ditto ditto. | | | |
| „ $1\frac{1}{2}$ miles N.N.E. | Ditto ditto. | | | |
| „ 1 mile N.E. | Ditto ditto. | | | |
| „ 1 mile S.S.E. | Hesto. | | | |
| „ $1\frac{1}{2}$ miles S.E. | Ditto. | | | |
| Bara Cháda, $\frac{3}{4}$ of a mile N.N.E. | Johilla | Rewah | 23° 21' | 81° 4' |
| Bargauan, $\frac{1}{2}$ a mile N.W. | Jamúna, a tributary of Kasér. | „ | 23° 18' | 81° 44' |

| Village. | River. | State. | Lat. N. | Long. E. |
|--|-------------------------------|---------|------------------------|----------|
| Bargauan, $\frac{1}{2}$ a mile E. . . | Jamúna, a tributary of Kasér. | Rewah. | | |
| Bacharuuar, $\frac{1}{2}$ a mile N. . . | A tributary of Kasér . | „ . | 23° 20' | 81° 49' |
| „ $\frac{1}{2}$ a mile E. . . | Ditto ditto. | | | |
| Basér, $\frac{1}{2}$ a mile W.N.W. . . | A tributary of Hesto . | Koréa . | 23° 21 $\frac{1}{2}$ ' | 82° 25' |
| „ 1 mile W.N.W. . . | Ditto ditto. | | | |
| „ 1 mile S.W. . . | Jura, a tributary of Hesto. | | | |
| „ 1 mile S.S.W. . . | Ditto ditto. | | | |
| „ 1 $\frac{1}{2}$ miles S.S.W. . . | Ditto ditto. | | | |
| „ $\frac{3}{4}$ of a mile S.E. . . | Darpani. | | | |
| „ 1 mile S.E. . . | Ditto. | | | |
| Bhalmúri, $\frac{1}{2}$ a mile E.S.E. . . | Kúlharia . . . | Rewah . | 23° 11' | 82° 09' |
| Bhoswái, $\frac{1}{2}$ a mile S.W. . . | A tributary of Hesto . | Koréa . | 23° 24' | 82° 37' |
| „ $\frac{1}{2}$ a mile W. . . | Ditto ditto. | | | |
| Bichia, $\frac{1}{2}$ a mile S.W. . . | Jamuniha, tributary of Són. | Rewah . | 23° 13' | 81° 43' |
| „ 1 mile W.S.W. . . | Són. | | | |
| Birhúli, $\frac{1}{2}$ a mile S.E. . . | A tributary of Són . | „ . | 23° 17' | 81° 37' |
| Chapáni, $\frac{1}{2}$ a mile S. . . | A tributary of Thema . | „ . | 23° 18' | 82° 01' |
| Charwáhi, $\frac{1}{2}$ a mile E. . . | Késlára . . . | „ . | 23° 27' | 82° 4' |
| „ 1 mile S.E. . . | „ | „ . | | |
| Chatai, south of village (near it.) | A tributary of Kúnuk . | | 23° 29' | 81° 56' |
| „ 1 mile N.E. . . | Ditto ditto. | | | |
| Chatán, $\frac{1}{2}$ a mile S. . . | Gandra nadi . . . | Koréa . | 23° 25' | 82° 11' |
| Chatei, $\frac{1}{2}$ a mile N.E. . . | Kéwai . . . | Rewah . | 23° 22' | 82° 5' |
| Chinmár, $\frac{1}{2}$ a mile S.W. . . | Goirári . . . | „ . | 23° 17' | 81° 54' |
| Chitájhór, $\frac{1}{2}$ a mile S.S.W. . . | Kauria nadi, branch . | Koréa . | 23° 23 $\frac{1}{2}$ ' | 82° 23' |

| Village. | River. | State. | Lat. N. | Long. E. |
|----------------------------------|---|------------|---------|----------|
| Chúrcha, 1½ miles N.W. . . | A tributary of Géj . | Koréa. . | 23° 20' | 82° 36' |
| „ 1 mile N.N.E. . . | Ditto. | | | |
| „ ¾ of a mile N.E. . . | Ditto. | | | |
| „ 1 mile E.N.E. . . | Ditto. | | | |
| Delbhákherúa, ¾ of a mile E.S.E. | A tributary of Kúnuk . | Rewah . | 23° 25' | 81° 56' |
| „ 1 mile E.S.E. . . | | | | |
| Déokhól, 1 mile N. . . | In a tributary of Géj . | Koréa . | 23° 22' | 82° 39' |
| Déori, 1½ miles S.W. . . | Kasér . . . | Rewah . | 23° 17' | 81° 41' |
| Dhakar, at the Ghât . . . | A tributary of Kúnuk . | „ . | 23° 28' | 81° 55' |
| Dhanpúri, ¾ of a mile S.S.E. | Bagéha, tributary of Són | „ . | 23° 11' | 81° 37' |
| „ ¾ of a mile E.S.E. . . | | | | |
| „ ¾ of a mile N.N.E . . | Nargara, tributary of Bagéha. | | | |
| Dhúmádól, ½ a mile S.W. . . | Katna | „ . | 23° 22' | 81° 50' |
| „ ¾ of a mile E.S.E. . . | Ditto. | | | |
| Dhúnd, 1 mile N.E. . . | A tributary of Máhan . | Jhilmili . | 23° 29' | 82° 55' |
| Diápipar, ½ a mile S.S.E. . . | A tributary of Són . | Rewah . | 23° 26' | 81° 26' |
| Dúbchóla, 1½ miles N. . . | Gurgheta . . . | Koréa . | 23° 9' | 82° 27' |
| Dúgla, ¾ of a mile E.N.E. . . | Khátomadhar . . . | Rewah . | 23° 25' | 82° 7' |
| Dúmarkachár, 1 mile N. . . | Kúlharia, tributary of Hesto. | „ . | 23° 10' | 82° 9' |
| „ 2 miles S.E. . . | At the junction of Jhiria and Kúlharia. | | | |
| Ghorbei, 1 mile N.E. . . | Nagana | Rewah . | 23° 20' | 81° 36' |
| Ghúnghúta, ½ a mile N. . . | A tributary of Kúnuk . | „ . | 23° 25' | 81° 55' |
| Ghútra, 1 mile W.S.W. . . | Hesin | Koréa . | 23° 21' | 82° 18' |
| „ 1 mile W. . . . | Ditto. | | | |
| „ 1½ miles W.S.W. . . | Ditto. | | | |

| Village. | River. | State. | Lat. N. | Long. E. |
|---|--------------------------------------|---------|------------------------|----------|
| Għutra, $\frac{1}{2}$ miles W.S.W. . . | Hesin. | | | |
| „ 2 miles S.W. . . | Ditto. | | | |
| „ $2\frac{1}{4}$ miles S.W. . . | Ditto. | | | |
| „ $\frac{1}{2}$ a mile S.E. . . | Ditto. | | | |
| Gúráru, $\frac{1}{2}$ a mile S.W. of Southern Tola. | Són | Rewah . | 23° 29' | 81° 23' |
| „ $\frac{1}{2}$ a mile N.E. of Southern Tola. | Koilári, tributary of Són | | | |
| Gúridánd, $\frac{1}{4}$ of a mile N. . . | Kéwai | „ . | 23° 21' | 82° 5' |
| „ 1 mile N.E. . . | Ditto. | | | |
| „ $1\frac{1}{2}$ miles N.N.E. . . | Ditto. | | | |
| „ $1\frac{1}{2}$ miles N.N.W. . . | Ditto. | | | |
| Harra, $\frac{1}{4}$ of a mile N.W. . . | Eastern tributary of Júra | Koréa . | 23° 17 $\frac{1}{2}$ ' | 82° 25' |
| „ $\frac{1}{2}$ a mile N.N.W. . . | Ditto ditto. | | | |
| „ $\frac{3}{4}$ of a mile N.N.W. . . | Ditto ditto. | | | |
| „ 1 mile W.N.W. . . | Ditto ditto. | | | |
| „ $1\frac{1}{2}$ miles N.W. . . | Ditto ditto. | | | |
| Hatgalá, $\frac{1}{2}$ a mile E.S.E. . . | Jamúna, tributary of Kasér. | Rewah . | 23° 19' | 81° 44' |
| Jaintpúr, $1\frac{1}{4}$ miles W.N.W. . . | Khaparkúta nadi, tributary of Kúnuk. | „ . | 23° 28' | 81° 46' |
| Jamúna, $\frac{1}{2}$ a mile N. . . | Tanki nadi, tributary of Múrna. | „ . | 23° 17 $\frac{1}{2}$ ' | 81° 26' |
| Jarra, 1 mile S.S.W. . . | Késlára nadi . . . | „ . | 23° 24' | 82° 4' |
| „ 1 mile E.S.E. . . | Ditto. | | | |
| Jauári, $\frac{1}{2}$ a mile N. . . | Dhoran nadi, tributary of Kúnuk. | „ . | 23° 25' | 81° 49' |
| Kachár, $\frac{1}{2}$ a mile N.N.E. . . | A tributary of Dhób nadi. | Koréa . | 23° 19' | 82° 26' |
| „ $\frac{1}{2}$ a mile S.E. . . | Ditto ditto. | | | |
| „ $\frac{1}{2}$ a mile E. . . | | | | |

| Village. | River. | State. | Lat. N. | Long. E. |
|---------------------------------|--------------------------------------|--------|----------|----------|
| Kachái, 1 mile N.E. | | | | |
| „ 1½ miles E.N.E. | | | | |
| Kálésar, at the Ghát | In the right bank of Umrár. | Rewah | 23° 31' | 80° 53' |
| „ a few score yards W. | In a tributary of the Umrár. | | | |
| „ ¾ of a mile W.S.W. | In a tributary of Umrár near temple. | | | |
| Kamta, 1 mile S.S.E. | Kúnuk | „ | 23° 27' | 81° 46' |
| Kanai, ½ a mile N.N.W. | Tributary of the Kéwai | „ | 23° 19' | 82° 12' |
| „ ¼ of a mile W.N.W. | | | | |
| „ 1 mile W.S.W. | | | | |
| Kanchanpúr, ½ a mile N. | A tributary of Sarpa | „ | 23° 15' | 81° 30' |
| Kánnabahára, ¼ of a mile N.W. | A tributary of Múrná | „ | 23° 19' | 81° 21' |
| Kanwáhi, 1 mile N. | In Khairi stream, tributary of Són. | „ | 23° 23' | 81° 32' |
| Kanwáhi, W. of, near the Ghát | Késlára. | „ | 23° 25' | 82° 4' |
| „ ½ a mile N.E. | Ditto. | | | |
| Kaparia, N.W. of, at the Ghát | Kéwai. | „ | 23° 24' | 82° 12' |
| „ ¾ of a mile N.N.W. | Ditto. | | | |
| Kelhauri, ½ a mile N. | Són. | „ | 23° 11' | 81° 40' |
| Khairbana, 1½ miles S.S.E. | Kauria. | Koréa | 23° 13½' | 82° 19' |
| Khamaria, ¼ of a mile N.W. | A tributary of Kúnuk. | Rewah | 23° 27' | 81° 56' |
| „ ½ a mile N.E. | Ditto ditto. | | | |
| „ 1 mile N.E. | | | | |
| Kharla, ¾ of a mile N.N.E. | | „ | 23° 17' | 81° 40' |
| Khodargaoan, ¾ of a mile N.N.E. | Dhóbghata, tributary of Jóhilla. | „ | 23° 21' | 81° 2' |
| „ ¾ of a mile E.N.E. | Marjada tributary of Jóhilla. | | | |

| Village. | River. | State. | Lat. N. | Long. E. |
|--|--|------------|---------|------------------------|
| Khohára, 1 mile E.N.E. . . | Ghordéna nadi. | Rewah . | 23° 31' | 81° 49' |
| Kichri, $\frac{3}{4}$ of a mile S. . . | In a tributary of Kúúúk, " in the Ghát N. of the village | ditto . | 23° 28' | 81° 54' |
| " $\frac{1}{4}$ of a mile N. . . | Bichli nadi. | | | |
| " 1 mile N.N.E. . . | Ditto. | | | |
| " $1\frac{1}{2}$ miles N.E. . . | Ditto. | | | |
| Kirwáhi, $1\frac{1}{4}$ miles W.S.W. . . | Hesto. | Koréa . | 23° 20' | 82° 22' |
| " a few score yards W. . . | At the falls in Hesto. | | | |
| " $1\frac{1}{4}$ miles N. . . | Hesto. | | | |
| Korar, $\frac{1}{2}$ a mile S.E. . . | In a tributary of the Umrár. | Rewah . | 23° 37' | 80° 55' |
| " $1\frac{1}{4}$ miles E.S.E. . . | Ditto ditto. | | | |
| Kóta, $\frac{1}{2}$ a mile N.E. . . | Goirári nadi. | " . | 23° 22' | 81° 53' |
| " $\frac{3}{4}$ of a mile E.N.E. . . | A tributary of Goirari nadi. | | | |
| Kótí, 1 mile S. . . | Goirári nadi. | " . | 23° 24' | 81° 54' |
| Kótmi, $\frac{1}{2}$ a mile N.W. . . | In a tributary of Kúdra, Hesto. | | 23° 10' | 82° 28 $\frac{1}{2}$ ' |
| " 1 mile N. . . | Ditto ditto. | | | |
| Kúndhour, just N.E. . . | In a tributary of Góknai. | Jhilmili . | 23° 25' | 82° 46' |
| " $\frac{1}{2}$ a mile N.E. . . | Ditto ditto. | | | |
| " just S. . . | Ditto ditto. | | | |
| " $\frac{3}{4}$ of a mile S.E. . . | Ditto ditto. | | | |
| " 1 mile S.S.E. . . | Ditto ditto. | | | |
| " $1\frac{1}{4}$ miles S.E. . . | Ditto ditto | | | |
| " $\frac{3}{4}$ of a mile W. . . | Ditto ditto. | | | |
| " $\frac{3}{4}$ of a mile W.S.W. . . | Ditto ditto. | | | |
| Kúpi, 1 mile S.W. . . | A tributary of Góknai. | " . | 32° 24' | 82° 43' |
| Kúráśia, $\frac{1}{2}$ a mile S.E. . . | Kúdra branch, tributary of Hesto. | Koréa . | 23° 14' | 82° 27' |

| Village. | River. | State. | Lat. N. | Long. E. |
|--------------------------------|---|--------|----------|----------|
| Kúrásia, 1½ miles S.E. . . | Kúdra branch, tributary of Hesto. Ditto ditto. | | | |
| „ 2 miles S.E. . . | | | | |
| „ 1½ miles S. . . | Gorghéta nadi branch, tributary of Hesto. | | | |
| Kúréli, 1 mile S.W. . . | Bichli nadi, tributary of Kasér. | Rewah | 23° 23½' | 81° 48' |
| „ 1 mile W.S.W. . . | Joba nadi, tributary of Kasér. | | | |
| Kúsáha, S.E. . . | Hesto . . . | Koréa | 23° 26' | 82° 32' |
| Kúshai, ¾ of a mile N. . . | Són . . . | Rewah | 23° 23' | 81° 27' |
| „ ½ a mile W.S.W. . . | Taptaí, tributary of Són. | | | |
| Labji, 1 mile S.S.W. . . | A tributary of Jhúnka nadi. | Koréa | 23° 23' | 82° 32' |
| „ 1½ miles S.S.W. . . | Ditto ditto. | | | |
| Lai, ¾ of a mile N.E. . . | A tributary of Hesto . . | „ | 23° 17½' | 82° 21' |
| Lama, 1 mile S.W. . . | Thema, tributary of Són | Rewah | 23° 17' | 82° 1' |
| Latma, ¾ of a mile N. . . | Tributary of Hesto . . | Koréa | 23° 22½' | 82° 37' |
| Mangthar, ½ a mile S.S.W. . . | Jóhilla river . . . | Rewah | 23° 18' | 81° 7' |
| Maiki, 1 mile N.N.W. . . | Goraghát nadi, tributary of Són. | „ | 23° 21' | 81° 28' |
| Malga, 1 mile N. . . | Jhíria . . . | „ | 23° 8' | 82° 7' |
| „ 1¼ miles E. . . | Ditto . . . | | | |
| Manjíra, ¾ of a mile W. . . | Katna . . . | „ | 23° 16' | 81° 51' |
| Mariarás, 1 mile E. . . | Bakán . . . | „ | 23° 8' | 81° 41' |
| Mouhári, ½ a mile S.E. . . | Késlára . . . | Koréa | 23° 26' | 82° 4' |
| Múrdhoa, ¼ of a mile W. . . | Goirári . . . | Rewah | 23° 15½' | 81° 55½' |
| Músra, 2 miles N.N.W. . . | A tributary of the Kawai. | „ | 23° 22' | 82° 16' |
| „ 1 mile S.S.W. . . | Ditto ditto. | | | |
| Nandna, ¾ of a mile E.N.E. . . | Nagaua . . . | „ | 23° 20' | 81° 33' |
| „ 1 mile N.E. . . | Tributary of Són . . | | | |
| „ 1 mile S. . . | Ditto ditto. | | | |
| Nerúa, 1 mile N. . . | A tributary of Khatoma-dhar. | Koréa | 23° 25' | 82° 11' |

| Village. | River. | State. | Lat. N. | Long. E. |
|--|-------------------------------|--------------|------------------------|------------------------|
| Nimuha, $\frac{1}{2}$ a mile E. . . | A tributary of Kasér . . | Rewah . . | 23° 19' | 81° 40' |
| „ $\frac{3}{4}$ of a mile N.E. . . | | | | |
| Pachkura, $\frac{1}{2}$ a mile N.E. . . | A tributary of Kéwai . . | „ . . | 23° 21' | 82° 4' |
| Paiari, 2 miles S.W. . . | Kéwai . . . | „ . . | 23° 9' | 82° 4' |
| Pakariha, $\frac{1}{2}$ a mile S.E. . . | A tributary of Thema, Són. . | „ . . | 23° 15 $\frac{1}{2}$ ' | 81° 59' |
| Pathargaua, 1 $\frac{1}{2}$ miles S.E. . . | A tributary of Góknai . . | Koréa . . | 23° 26' | 82° 38' |
| Pipria, $\frac{1}{2}$ a mile S.W. . . | A tributary of Kéwai . . | Rewah . . | 23° 23' | 82° 8' |
| „ $\frac{1}{2}$ a mile N.W. . . | | | | |
| Rámpúr, $\frac{3}{4}$ of a mile N.W. . . | Jamúniha, tributary of Són. . | „ . . | 23° 13' | 81° 44' |
| „ 1 mile S.S.W. . . | Katna. . | | | |
| „ $\frac{1}{2}$ a mile S.S.W. . . | Ditto. . | | | |
| Raksa, 1 mile S.E. . . | Goirári . . . | „ . . | 23° 9' | 81° 53' |
| Rataura, 1 mile N.E. . . | Gúndrákúnd . . . | Koréa . . | 23° 23' | 82° 14' |
| „ $\frac{1}{4}$ of a mile W.N.W. . . | | | | |
| „ 1 mile W. . . | | | | |
| Róji, $\frac{1}{2}$ a mile S.E. . . | | „ . . | 23° 26' | 82° 7 $\frac{1}{2}$ ' |
| Roudserai, 1 mile N.N.E. . . | A tributary of Góknai . . | „ . . | 23° 26' | 82° 41' |
| „ 1 mile N.E. . . | Ditto ditto. . | | | |
| Rohania, $\frac{1}{2}$ a mile N.E. . . | In a tributary of Són . . | Rewah . . | 23° 25' | 81° 27' |
| „ $\frac{3}{4}$ of a mile S. . . | A tributary of Són. . | | | |
| Rúndaha, 1 mile W.N.W. . . | Góknai . . . | Jhilmili . . | 23° 28 $\frac{1}{2}$ ' | 82° 43' |
| „ $\frac{1}{2}$ of a mile N.E. . . | A tributary of Góknai. . | | | |
| „ $\frac{3}{4}$ of a mile E.S.E. . . | Góknai. . | | | |
| Rúpaura, $\frac{1}{2}$ a mile S.W. . . | Katna . . . | Rewah . . | 23° 20' | 81° 52' |
| Sáhipúr, $\frac{1}{2}$ a mile S. . . | A tributary of Káser . . | „ . . | 23° 21' | 81° 46' |
| Sardih, $\frac{1}{4}$ of a mile S.S.E. . . | Goirári . . . | „ . . | 23° 17' | 81° 54 $\frac{1}{2}$ ' |
| Semariha, $\frac{1}{2}$ a mile E. . . | Ditto . . . | „ . . | 23° 16' | 81° 54' |

| Village. | River. | State. | Lat. N. | Long. E. |
|---------------------------------------|--|--------|-----------------------------|----------------------------|
| Semdib, $1\frac{1}{4}$ miles N. | At the junction of Kúnuk and Són. | Rewah | $23^{\circ} 23'$ | $81^{\circ} 30'$ |
| „ 1 mile N.N.E. | At the junction of Khairi stream with Són. | | | |
| Semriha, $\frac{1}{4}$ of a mile S.W. | Barúha, tributary of Són. | „ | $23^{\circ} 20'$ | $81^{\circ} 21'$ |
| Sóhágpúr, $\frac{1}{2}$ a mile N.W. | Múrna, tributary of Són | „ | $23^{\circ} 19'$ | $81^{\circ} 24'$ |
| Súnhat, 1 mile S.S.E. | Hesto | Koréa | $23^{\circ} 29'$ | $82^{\circ} 34'$ |
| „ $1\frac{1}{4}$ miles S.S.E. | Ditto. | | | |
| Tanjára, $1\frac{1}{2}$ miles S.E. | A tributary of Góknai | „ | $23^{\circ} 29'$ | $82^{\circ} 39'$ |
| Tánki, 2 miles E.S.E. | Batidhar nadi, tributary of Hesto. | Rewah | $23^{\circ} 7'$ | $82^{\circ} 9'$ |
| „ 2 miles S.E. | Neori nadi, tributary of Hesto. | | | |
| Terriha, $\frac{1}{2}$ a mile W. | A tributary of Kasér, Són. | „ | $23^{\circ} 18'$ | $81^{\circ} 41'$ |
| „ $\frac{1}{2}$ a mile W.N.W. | Jamúna, tributary of Kasér. | | | |
| Thángnon, $1\frac{1}{2}$ a mile N. | A tributary of Kéwai | „ | $23^{\circ} 18'$ | $82^{\circ} 10\frac{1}{2}$ |
| „ $1\frac{1}{2}$ miles E.S.E. | A tributary of Gandrá-kúnd. | | | |
| Thuthi, $\frac{1}{2}$ a mile N. | A tributary of Són | „ | $23^{\circ} 10'$ | $81^{\circ} 51'$ |
| Titripáni, $\frac{1}{2}$ a mile S.E. | Nagrári nadi | „ | $23^{\circ} 8'$ | $81^{\circ} 55'$ |
| Udri, $\frac{1}{2}$ a mile N.E. | Múrna | „ | $23^{\circ} 24\frac{1}{2}'$ | $81^{\circ} 21'$ |
| Umaria, see Kálésar. | | | | |
| Urtán, 1 mile S.W. | Chaurár nadi | „ | $23^{\circ} 19'$ | $82^{\circ} 1'$ |
| „ $\frac{1}{2}$ a mile S.S.W. | | | | |

NOTE.—The latitude and longitude in some instances refer to the position of the coal seam, and in others to the village.

LÁLA HIRA LÁL.

1st October 1884.

SECTION

Analyses of Coals, from the Southern Coal-

| Name of Village and other sites. | Rivers. | Water, hygro- scopic and com- bined. | EXCLUSIVE OF WATER.* | | |
|-------------------------------------|-------------------------------------|---|----------------------|------------------|-------|
| | | | Percentages. | | |
| | | | Volatile Matter. | Fixed Carbon. | Ash. |
| Balbahárá, 1½ miles, N.N.E. (Koréa) | | 6·4 | 28·85 | 53·42 | 17·73 |
| „ „ „ „ „ | | 5·63 | 30·42 | 57·51 | 12·07 |
| „ „ „ „ „ | | 5·6 | 27·84 | 51·32 | 20·84 |
| „ „ „ „ „ | | 5·92 | 29·03 | 54·09 | 16·50 |
| Bélha Paiári (Rewah) | Kéwai . . . | 10·3 | 25·49 | 63·54 | 10·97 |
| Bichia, near | Jamúnia Nadi . | 5·8 | 31·3 | 58·4 | 10·3 |
| | Billa and Bagéha Nadis, junction. | 7·76 | 36·90 | 55·25 | 7·85 |
| Gúráru | Són . . . | 2·7 | 9·8 | 41·6 | 48·6 |
| Gúrrha and Bhagáh | River between . | 7·4 | 29·3 | 46·35 | 24·62 |
| Hatgala, about 1 mile S.E. | Nala joining Jamúnia | 12·28 | 28·64 | 59·28 | 12·08 |
| | Jóhilla . . . | 12·7 | 31·23 | 58·23 | 10·54 |
| | „ . . . | 9·08 | 29·39 | 54·05 | 16·56 |
| | „ Marjada Nala | 10·30 | 32·31 | 54·58 | 13·11 |
| | | 11·8 | 35·60 | 52·77 | 11·63 |
| | | 8·14 | 36·64 | 55·93 | 7·43 |
| | | 11·9 | 34·26 | 51·53 | 14·21 |
| | Karakachár Nadi . | 2·26 | 9·84 | 49·52 | 40·64 |
| Khairi (Rewah) | Junction of a rivulet with the Són. | 4·2 | 20·12 | 27·06 | 52·82 |
| | | 3·28 | 29·90 | 43·30 | 26·80 |
| | | 5·2 | 27·30 | 47·26 | 25·44 |
| | Khóki and Kéwai Nadis, junction. | 2·12 | 21·01 | 45·50 | 33·49 |
| Korár, S.E. | | 5·4 | 13·22 | 68·96 | 17·82 |
| | Kúlharia Nadi . | 6·7 | 30·2 | 63·9 | 5·9 |
| Kundhour, ½ mile N.E. (Jhilmili). | | 4·22 | 17·10 | 73·40 | 9·50 |
| „ ½ mile S.E. | „ . | 2·36 | 24·16 | 68·57 | 7·27 |
| Kúráisia, ½ mile S.E. (Koréa) | | 2·20 | 29·09 | 64·65 | 6·26 |

* In order to reduce these numbers to a common standard, the results are given in percentages of dry coal.

XXIV.

fields of the Rewah Gondwana Basin.

| Analyst. | POSITION OF VILLAGE ON MAP. | | REMARKS. |
|----------|-----------------------------|--------------|---|
| | Latitude N. | Longitude E. | |
| H. L. | 23° 18' | 82° 19' | Does not cake. Ash brownish. |
| " | ... | ... | " " " reddish. |
| " | ... | ... | " " " " |
| " | ... | ... | |
| " | 23° 9' | 82° 4' | Does not cake. Ash reddish. Position of Paiári given. |
| " | 23° 14' | 81° 44' | " " " " grey. |
| " | ... | ... | Cakes. Colour of ash brick-red. |
| F. R. M. | 23° 29' | 81° 23' | Does not cake. Ash reddish. |
| H. L. | 23° 21' | 81° 34' | Cakes. Ash brownish. |
| " | 23° 19' | 81° 44' | Does not cake. Ash reddish-brown. |
| " | ... | ... | Bottom part of seam. |
| " | ... | ... | Does not cake. Ash greyish. |
| " | ... | ... | " " " " Middle of bottom seam. |
| " | ... | ... | " " " white. Below middle of bottom seam. |
| " | ... | ... | " " " reddish. Lower part of bottom seam |
| " | ... | ... | " " " greyish.† |
| " | ... | ... | Does not cake. Ash bluish-grey. |
| " | 23° 25' | 81° 34' | " " " reddish-grey. |
| " | ... | ... | Cakes partially. Ash reddish. |
| " | ... | ... | Does not cake. Ash greyish. |
| " | ... | ... | " " " brownish. |
| " | 23° 37' | 80° 56' | " " " reddish. |
| " | ... | ... | " " " " |
| " | 23° 25' | 82° 45' | " " " brownish. |
| " | ... | ... | " " " red. |
| " | 23° 14' | 82° 28' | Cakes. Ash reddish. |

† Picked out promiscuously from heap quarried for despatch to railway.

| Name of village and other sites. | Rivers. | Water, hygro- scopic and com- bined. | EXCLUSIVE OF WATER.* | | |
|---------------------------------------|------------------------------|---|----------------------|------------------|-------|
| | | | Percentages. | | |
| | | | Volatile Matter. | Fixed Carbon. | Ash. |
| Kúráisia, 1½ miles S.S.W. (Koréa) | . | 6·84 | 32·43 | 59·95 | 7·62 |
| Maiki (Rewah) . | . | 3·27 | 19·40 | 61·33 | 19·27 |
| Mangthár . . | Jóhilla . . . | 8·42 | 32·08 | 50·62 | 17·30 |
| Mangthár and Lakhan- púra, between | ,, right bank . | 7·06 | 38·37 | 42·80 | 18·83 |
| Nandnah . . | Són . . . | 2·94 | 23·84 | 62·50 | 13·66 |
| . . | ,, . . . | 3·2 | 26·55 | 62·89 | 10·56 |
| . . | ,, . . . | 4·8 | 18·28 | 48·15 | 33·57 |
| Nérua (Koréa) . | Nérua Nala, N. branch of. | 8·28 | 29·57 | 53·29 | 17·14 |
| Pipria (Rewah) . | Kéwai . . . | 4·2 | 18·6 | 57·4 | 24·0 |
| Sáhipúr . . | | 7·88 | 32·05 | 51·67 | 16·28 |
| | Tendutola Village, Nala. | 3·08 | 22·49 | 55·63 | 21·88 |
| | ,, . | 1·84 | 22·57 | 51·02 | 26·41 |
| Umaria . . | Umrár . . . | 11·3 | 33·15 | 51·63 | 15·22 |
| . . | ,, . . . | 1·6 | 30·3 | 61·2 | 8·5 |
| . . | ,, . . . | 5·8 | 25·1 | 55·6 | 19·3 |
| . . | ,, . . . | 3·6 | 31·1 | 55·6 | 13·3 |
| . . | ,, . . . | 2·6 | 20·1 | 58·7 | 21·2 |
| . . | ,, . . . | 3·4 | 35·6 | 56·9 | 7·5 |
| . . | ,, . . . | 2·2 | 25·0 | 36·4 | 38·6 |
| . . | ,, . . . | 2·4 | 26·4 | 60·9 | 12·7 |
| . . | ,, . . . | 2·4 | 26·7 | 59·2 | 14·1 |
| . . | ,, . . . | 2·6 | 30·0 | 53·6 | 16·4 |
| . . | ,, . . . | 2·8 | 28·4 | 60·7 | 10·9 |
| . . | ,, . . . | 2·98 | 26·82 | 58·71 | 14·47 |
| . . | ,, . . . | 3·16 | 33·19 | 58·39 | 8·42 |
| . . | ,, . . . | 2·66 | 24·00 | 38·87 | 37·13 |
| . . | ,, . . . | 2·40 | 20·90 | 38·36 | 40·74 |
| . . | ,, . . . | 5·46 | 25·17 | 66·71 | 8·12 |

* In order to reduce these numbers to a common standard, the results are given in percentages of dry coal.

| Analyst.† | POSITION OF VILLAGE ON MAP. | | REMARKS. |
|-----------|--------------------------------|-----------------|--|
| | Latitude N. | Longitude E. | |
| H. L. | ... | ... | Cakes partially. Ash red. |
| „ | 23° 22' | 81° 28' | Does not cake. Ash reddish. |
| „ | 23° 18' | 81° 7' | „ „ „ grey. |
| „ | 23° 17'‡ | 81° 6' | „ „ „ greyish. |
| „ | ... | ... | Cakes. Ash greyish, |
| „ | ... | ... | Cakes partially. Ash brownish. |
| „ | 23° 20' | 81° 32' | Does not cake. Ash brownish. |
| „ | 23° 25' | 82° 11' | „ „ „ „ |
| „ | 23° 23' | 82° 8' | „ „ „ „ |
| „ | 23° 21' | 81° 46' | Cakes partially. Ash brownish. |
| „ | ... | ... | Does not cake. Ash dull-red. |
| „ | ... | ... | Cakes. Ash brownish-red. |
| F. R. M. | 23° 32' | 80° 54' | Does not cake. Ash reddish. Analysis of outercrop coal. June 1880. |
| „ | „ | „ | Does not cake. Ash white. |
| H. L. | „ | „ | „ „ „ „ (a) 0' 6". Hard coal. |
| „ | „ | „ | „ „ „ „ pinkish-white. (c) 0' 6". Bright coal, soft. |
| „ | „ | „ | Does not cake. Ash greyish-white. (d) 0' 7". Clinker band. |
| „ | „ | „ | Does not cake. Ash white. (e) 0' 6". Bright coal, soft. |
| F. R. M. | „ | „ | „ „ „ „ (f) 0' 4". Hard coal (Oil coal,—heavy oils, and tarry matter about 15 per cent.) |
| H. L. | „ | „ | Does not cake. Ash white. (h) |
| „ | „ | „ | „ „ „ „ (h) 2' 0". Hard coal. |
| „ | „ | „ | „ „ „ „ (h) Specimens from four different parts of the seam. |
| „ | „ | „ | Cakes only partially. Ash white. (h) |
| „ | „ | „ | Does not cake. Ash white. Hard coal for Exhibition. |
| „ | „ | „ | Cakes. Ash white. Soft coal. |
| „ | „ | „ | Does not cake. Ash greyish. Carb. shale above coal (a). Rec., G.S.I., Vol. XVI, pt. 2, p. 120. |
| „ | „ | „ | Does not cake. Ash greyish-white. Carb. shale in the bottom, 2 feet hard coal. |
| F. F. | „ | „ | Does not cake. Top coal. No. 2 shaft. |

† H. L. signifies Hira Lál.

F. R. M. „ Mallet.

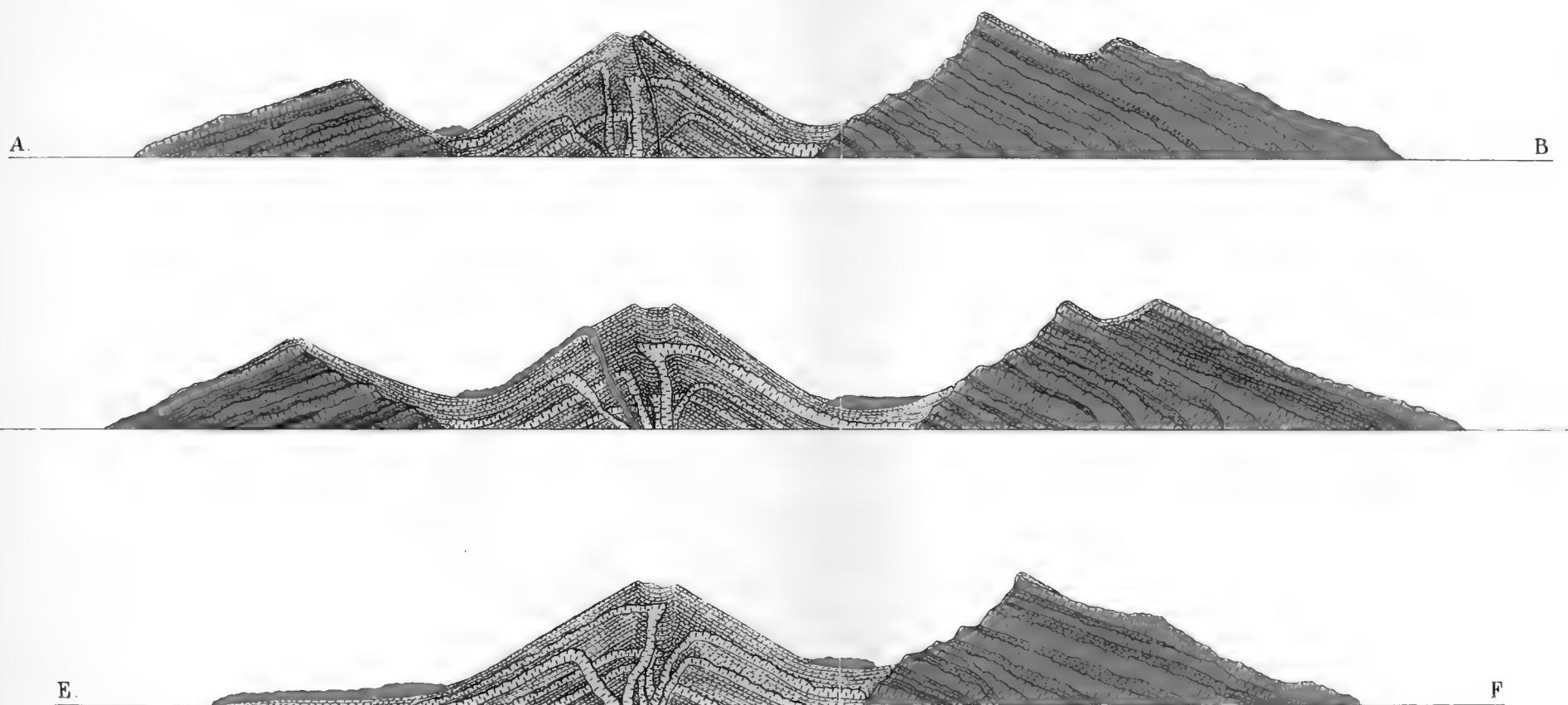
F. F. „ Fedden.

‡ Lakhampura.

G E O L O G I C A L S U R V E Y O F I N D I A.

Mallet; Barren Island.

Memoirs, Vol. XXI.



Older products of eruption.



Newer products of eruption.



Most recent lava, ...



Alluvial volcanic sand,



Scale 4 Inches = 1 Mile

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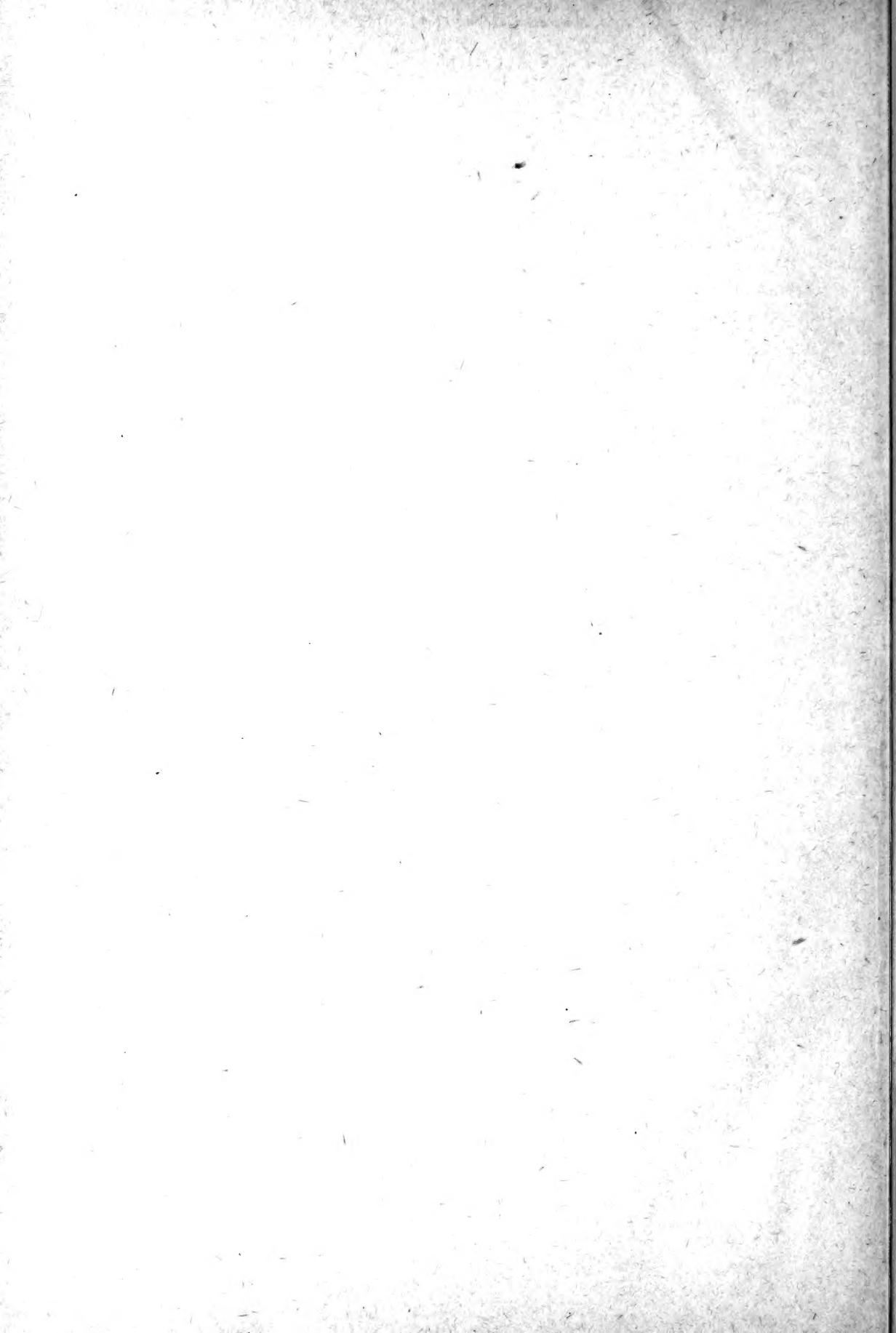
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